DIPHENYL
AND
CHLORINATED DIPHENYL DERIVATIVES

JUNE 1935

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INTRODUCTION

This report relates to the manufacture of Diphenyl and Chlorinated Diphenyl Derivatives. It is submitted to those at the St. Louis Plant in connection with moving these operations from the Anniston Plant to the East St. Louis Plant.

A description is given of the equipment and operations of the Diphenyl and Derivatives plant at Anniston, both in text and prints. We have investigated our present plant and operations and have pointed out improvements that would be advisable in a new plant. These improvements are set out in both text and prints.

No attempt has been made to lay out the new plant or detail the equipment, as neither the size of the buildings to be occupied nor the capacity of the units to be installed is known. To assist those who design this plant we are sending a complete set of prints, both assembly and detail, showing the equipment as it is installed at present. It is hoped that much of the equipment at Anniston can be used in the new plant.

Several members of the Anniston organization have written the various sections of this report. Between these sections there has been some repetition. It is felt, however, that this is desirable for at St. Louis different groups may be principally interested in individual sections.

Made a part of this report are data sheets, heat balances, product specifications, etc., designed to help those who will construct and operate these units.

This report is prepared in quadruplicate, one copy being sent to Mr. DuBois, two copies to Mr. Livingston, and one copy being kept in the Anniston files.

E. H. Buford

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SECTION NO. 1

NOTES ON DIPHENYL AND DIPHENYL DERIVATIVES PLANTS EQUIPMENT, BOTH PRESENT AND PROPOSED BY:

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The Drawings Referred to in This Section are:

DIPHENYL UNIT

0-6831 – Diphenyl Plant – Diagrammatic Flow Sheet of Present Plant.

Sc-2403 – Proposed Converter Unit and Separating Equipment

CHLORINATING UNIT

0-6832 – Diagrammatic Layout of Chlorinating Equipment
0-6835 – Layout of Chlorinators
Sc-2404 – Suggested Layout of Chlorinators for Proposed Plant

HCl ABSORPTION

No Drawings

AROCLOR NO. 1269

Sc-2407 – Proposed Layout of "1269" Plant

AROCLOR DISTILLATION
0-6838 – Layout of Badger Still
Sc-2405 – Proposed Distillation Equipment for Liquid Aroclors
Sc-2406 – Proposed Distillation Equipment for Solid Aroclors

ASSEMBLY OF PLANTS (PROPOSED)

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Sc-2402 – Proposed General Layout of Plant

DIPHENYL PLANT EQUIPMENT

A unit for producing diphenyl at St. Louis having a capacity of 1,000,000 lbs. per year may follow one of two arrangements.

The first arrangement would be the removal and installation at St. Louis of the present three lead pot units without substantial alteration. Such an arrangement fired with natural gas at 30¢ per 1,000 cu. ft. would mean an increase of cost of production due to fuel alone of 0.158¢ per lb. or $1,580.00 per year over that of Anniston operations. However, by the elimination of the benzol still, which is later discussed, the reduction in steam costs would off-set the advance in gas costs and the total costs of heating could be brought in line with the heating costs at Anniston.

The second possibility and the one which seems the most desirable, and especially so if large production requiring a number of units can be forseen, is the installation of a two lead pot unit combined with heat exchangers and continuous fractionating columns. Since this arrangement would have lower heating costs than for the 3 pot unit with natural gas at 30¢ per 1,000 cu. ft., the costs for fuel would be reduced by 0.28¢ per lb. of diphenyl or $2,800.00 per year on 1,000,000 lbs. These fuel costs would be by the same amount less than Anniston costs. There would probably be additional savings in maintenance and labor which cannot be predicted at the present time.

This arrangement is a considerable departure from the present Anniston practice and its design and construction should be preceded by development work.

The following notes discuss the possible combinations that may be used for the production of diphenyl and the salient features of the present unit as compared with the suggested unit.

The outline for this discussion is:

1. Diphenyl Converter

    1. Plant Design

        1. General Discussion
        2. Reactor Vessels
        3. Fuels and Firing Equipment
        4. Settings
        5. Automatic Control Equipment
        6. Piping and Valves

    2. Operation

        1. Temperature and Rate of Operation

    3. Detailed Discussion of Suggested Two Pot Unit

2. Separation of Products

    1. Plant Design

        1. Equipment for Separating Benzol-Diphenyl-High Boiler Mixtures

        2. Storage of Benzol-Diphenyl-High Boiler

3. Recommendations

Comments on items as listed above are as follows:

DIPHENYL CONVERTER — PLANT DESIGN

ITEM 1.1.1. – GENERAL DISCUSSION

Diphenyl is produced by the heating of benzol vapor to a temperature around 800°C in closed vessels from which the air is excluded, condensing these products and separating diphenyl from the benzene and other converted products.

The most desirable diphenyl unit is one in which the maximum utilization of heat is combined with simplicity of operation and low cost of construction. The most satisfactory type of reactor vessel has been found by actual manufacturing experience in Anniston to be a steel pot containing molten lead through which the benzene vapor is passed. Although at first sight the lead bath appears to be an inefficient heat exchanger, close study has shown that it is exceedingly efficient. The lead bath has the particular advantage for an operation of this sort that any carbon formed tends to float on the lead surface or be carried out to a conveniently located trap rather than to plug the apparatus. All subsequent discussion will be confined to lead pot reactors.

The lead reactor pot or pots may be heated in various ways and may be combined with various heat exchange apparatus. The more important combinations are shown in Schedule 1.

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ARRANGEMENTS OF DIPHENYL CONVERTING EQUIPMENT AND HEAT EXCHANGERS

SCHEDULE 1

Arrangement No.	Kind of Heat Fuel	Equipment Required: Conversion — Heat Exchangers On: Converted Vapor Line	Flue Gas Stack	No. of Lead Pots	Steam Heated Benzene Vaporizer	Distillation: Continuous Column for Partial Concentr. of Converted Products	Steam Heated Benzene Still	Fuel Heated Diphenyl Still	Continuous Columns for Benzene Diphenyl & High Boiler Separation
1	Fuel	-	+	3	-	+	+	+	-
2	"	+	+	3	-	+	+	+	-
3	"	+	+	2	-	+	+	+	-
4	"	+	+	1	-	+	+	+	-
5	"	+	+	2	-	-	-	-	+
6	Electricity	+	-	1	+	-	+	+	-

\+ Indicates Required
\- Indicates Not Required

SCHEDULE 1

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In order to determine which arrangement is most economical to install and operate the variable costs for the various combinations are compared.

Labor and maintenance costs will also enter into the final obtainable costs but these cannot be predicted at this time.

The bases used for these computations are as follows:

1. Steam — 35¢ per 1000 lbs. at 100 lbs. pressure and utilizing only the latent heat. Equivalent to 40¢ per million B. T. U. (This is less than the cost of steam generated for the Anniston Diphenyl Operations by a small gas fired boiler.).

2. Natural gas at 20.5¢ per million B. T. U. (Anniston cost).

3. Water cost 28¢ per 1,000 cu. ft. (Average Anniston water cost, including city and reclaimed water.).

Heat requirements are taken from the heat balance recently made, notes and records available at Anniston. Where such information was not available, calculations have been made.

Installation Costs

The installation costs are only on a collection of isolated pieces of equipment and are without accessories. No designs have been made and the costs are only preliminary as follows:

1. One 3 pot converter – gas fired (Used in Arrangements 1 & 2)	$14,000.00
2. One 2 pot converter – gas fired (Used in Arrangements 3 & 6)	10,500.00
3. One 1 pot converter gas fired (Used in Arrangement 4)	7,000.00
4. One 1 pot converter – Electric heated (resistance) (Used in Arrangement 5)	8,000.00
5. Benzol Vaporizer in Flue Gas Stack (Used in Arrangements 1, 2, 3, 4, &5)	750.00
6. Heat exchanger in Converted Vapor line (Used in Arrangement 2, 3, & 5)	750.00
7. Heat exchanger in Converted Vapor line (Used in Arrangements 4 & 6)	1,100.00
8. Steam Heated Benzol Vaporizer (Used in Arrangement 6)	400.00
9. Continuous Fractionating Column (Used in Arrangement 1, 2, 3, & 4)	1,000.00
10. Steam Heated Benzol Still (Used in Arrangements 1, 2, 3, 4, & 6)	3,000.00
11. Fuel Heated Diphenyl Still (Used in Arrangements 1, 2, 3, 4 & 6)	5,400.00
12. Continuous Separation Equipment (Used in Arrangement 5 and price includes cost of necessary development work)	6,000.00

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All calculations are based on Anniston operations, namely a unit producing 3,000 lbs. of technical diphenyl a day. This corresponds to a total conversion per pass of 18% converted products, 78% of converted products being diphenyl and 22% being high boiler. The production of converted products requires theoretically 93.9% of the benzene actually used. The daily requirements of benzene are 4,160 lbs. per day.

Arrangement No. 1

This is the present arrangement at Anniston and as shown on our Drawing #C-6851.

The installation consists of 3 gas fired lead pots, with benzene entering through a vaporizer located in the stack for exit of combustion gases, and after conversion, then entering a fractionating column which partially concentrates the converted products. The mixture which discharges from the bottom of this column runs 50%-75% converted products, the balance being benzene.

The partial operating costs are as follows:-

	Per lb. Diphenyl
Fuel for Converter (Metered)	0.51¢
" " Diphenyl Still (Metered)	0.05
Steam for Benzol Still (Reflux ratio assumed as 1/2 to 1 and 75% efficiency and 21,160# benzol distilled per day)	0.10
Water for Dephlegmator and condensers on continuous column, benzol still and diphenyl still	0.20
Depreciation on Items 1,5,9,10&11, totalling $ 22,150.00 @ 10% on 1,000,000 lbs.	0.22
Total for Arrangement No. 1	0.98¢

Note: The above operations could be reduced by 0.15¢ by running the continuous column with minor alterations at a higher temperature so as to deliver a diphenyl and high boiler mixture and thereby eliminate the benzene still.

Arrangement No. 2

This arrangement would be identical to Arrangement No. 1 excepting that a heat exchanger would be used to recover heat from the vapors leaving the converter unit. Benzene would first pass through the vaporizer heated by the exit flue gases and then to the heat exchanger and then through the lead pot units. The converted vapors after leaving the heat exchanger would pass to the column for concentrating the converted products prior to going to the benzene still.

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On the assumption that the heat exchanger would recover 50% of the heat in the converted vapors, which would represent 18% of the total heat requirements, the heat efficiency of the operations would be increased from 45% to 63%.

The partial operating costs are as follows:-

	Per lb. Diphenyl
Fuel for Converter	0.22¢
" " Diphenyl Still (Metered)	0.03
Steam (Same as in Arrangement No. 1)	0.10
Water (Same as in Arrangement No. 1 excepting that less would be used on column)	0.17
Depreciation on Items 1,5,6,9,10 & 11, totalling $22,900.00 @ 10% on 1,000,000 lbs.	0.23
Total for Arrangement No. 2	0.75¢

Note: The above operations could be reduced by 0.15¢ by running the continuous column, after making minor alterations, at a higher temperature so as to deliver a diphenyl and high boiler mixture and thereby eliminate the benzene still.

Arrangement No. 3

This arrangement would be the same as Arrangement No. 2 excepting that one lead pot would be eliminated. This would necessitate putting the same heat into two pots that would be put into the three pots of Arrangement No. 2.

The partial operating costs are as follows:-

	Per lb. Diphenyl
Fuel - For Converter	0.22¢
" Diphenyl Still	0.03
Steam - Same as in Arrangement No. 1	0.10
Water - Same as in Arrangement No. 2	0.17
Depreciation on Items 2,5,6,9,10 & 11, totalling $ 19,400.00 @ 10% on 1,000,000#	0.19
Total for Arrangement No. 3	0.71

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Note: The above operations could be reduced by 0.15¢ by running the continuous column after making minor alterations at a higher temperature so as to deliver a diphenyl and high boiler mixture and thereby eliminate the benzene still.

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Arrangement No. 4

This arrangement is the same as Arrangement No. 3 except two of the lead pots would be eliminated.

The partial operating costs are as follows:-

	Per lb. Diphenyl
Fuel - For Converter	0.14¢
" Diphenyl Still	0.05
Steam - Same as Arrangement No. 1	0.10
Water	0.15
Depreciation on Items 3,5,7,9,10 & 11, totalling $ 16,250.00 @ 10% on 1,000,000 lbs.	0.16
Total for Arrangement No. 4	0.57¢

Arrangement No. 5

This arrangement consists of a two lead pot converter unit. The incoming benzene is vaporized and superheated in an exchanger located in the stack for exit combustion gases. This superheated benzene vapor attains additional superheat in an exchanger on the exit converted vapors from the converter unit. These partially cooled converted vapors then enter a system of columns which continuously discharge the separated benzene, diphenyl and high boiler.

This system is as shown on Drawing #8c-[illegible].

The partial operating costs are as follows:

	Per lb. Diphenyl
Fuel - For Converter	0.19¢
Steam	-
Water	0.15
Depreciation on Items 2,5,6 & 12, totalling $ 18,000.00 @ 10% on 1,000,000#	0.18
Total for Arrangement No. 5	0.52¢

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Arrangement No. 6

This arrangement consists of a single pot electrically heated. Heat exchangers are provided to have the exit converted vapors condense and impart their heat to the incoming benzene vapor. Columns would be provided for separating the benzene-diphenyl-high boiler.

The above cycle is identical to the Dow operations excepting that instead of the lead pot, Dow uses carbon tubes acting as resistors and heated by electricity. In the Dow process, benzene vapors are delivered directly from the top of the benzene column to the heat exchanger. Due to the head of the lead in our process, it would probably be inadvisable to operate this column under 16 lbs. pressure to save the energy of vaporizing the benzol.

The partial operating costs are as follow:-

	Per lb. Diphenyl
Electricity 90 K.W. @ 1/2¢,	0.36¢
Fuel for Diphenyl Still	0.05
Steam	0.21
Water	0.16
Depreciation on Items 4,7,8,10 & 11, totalling $ 15,900.00 @ 10% on 1,000,000#	0.16
Total for Arrangement 6	0.92¢

Note: If the heating was done by induction, the installation cost would be increased by $ 10,000.00- $15,000.00 and the operating cost up to 0.15¢ per pound diphenyl.

From the above, it is evident that Arrangement No. 5 is the cheaper to operate. This, however, is followed very closely by both Arrangements Nos. 2 & 5 with the continuous column operating so as to eliminate the benzol still.

ITEM 1.1.2. – REACTOR VESSELS

The pots used in this process have long life and low maintenance cost. Presumably these pots could be made larger and for greater capacities, but the life of such pots and the maintenance costs as compared with the present pots cannot be predicted.

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Our experience with pots is limited to welded pots of low carbon steel and also Crucible Steel Company's Rezistal No. 7, chromium 25-28% and nickel 20-22%. These pots have been made by two fabricators, but those made by the Blaw Knox Company have been most satisfactory.

The pot used on preheater No. 1 (the lowest temperature pot) is hammer welded low carbon steel. These pots have lasted well and the last lot purchased was in 1929, hence the hammer welding. Pots electrically welded would be equally as good. The depth of the lead in the pot is about 50". The inlet pipe for benzene vapor with distributor is made of 18% chromium, 8% nickel steel. The distributor pipe is secured to the steel cover which is then welded to the pot.

The pot used on preheater No. 2 (the intermediate temperature pot) is electrically welded Crucible Steel Company's Rezistal No. 7. The depth of the lead in the pot is about 48". The inlet pipe for benzene vapor along with distributor is made of 18% chrome - 8% nickel steel. This distributor pipe is secured to the cast steel cover which is then bolted to a cast steel flange(Van Stone Type) on the pot. The gasket used is a 5/16" diameter annealed copper hoop.

The converter pot (the highest temperature pot) is electrically welded Crucible Steel Company's Rezistal No. 7. The depth of the lead in the pot is about 42". The inlet pipe, same as above, is secured to the cast steel cover which is bolted to the flange on the pot. The gasket used is braided asbestos.

Due to the extreme temperatures, the bolted covers on the converter pot have been troublesome when insulated. The bolts would stretch and the joint would leak. Bare covers are now being operated and the bolts tightened as leaks develop. Alloy bolts have been tried but when the pot was cooled, they contracted and then had to be melted off.

It is but seldom necessary to enter the preheater pots; It is recommended that whether one or two are used, that the heads be welded to the shell and then insulated. This presumed that welders are available who can make high pressure welds in carbon steel.

The converter pot should have either a bolted cover or a welded cover provided welders are available who can make pressure welds in high chromium - high nickel steels. Welding is not easy after prolonged exposure to these high temperature vapors. It is believed that the preferred construction would be alloy bolts with thick washers made of a material whose coefficient of expansion is higher than the bolts and which would cause the bolts to loosen on cooling. Such would then be insulated, which would be so applied that it could readily be removed for access to the bolts or else removing the cover of the pot.

It has been suggested that the agitators or contactors be used in the lead of these pots to reduce the bubble size and thereby increase the contact between the benzene vapor and the molten lead. The organization at Anniston have had no experience with such devices, but it is their belief that maintenance costs might be sufficient to offset the gain in capacity or recovery attained through its use. It is suspected that the shaft of such a contactor would either distort or else cut itself in the submerged bearing in the molten lead if such bearings were use.

We understand that the St. Louis Research Department has experimented with such a contactor in a heated lead reactor vessel. Their experience should abundantly have precedence over our beliefs.

ITEM 1. 1. 5. – FUELS & FIRING EQUIPMENT

Regarding fuel in the East St. Louis Plant, we have data as follows:-

	Price per Million B.T.U. Content.
Electricity assumed at 1/2¢ / K.W.H.	$ 1.466
City Gas - 750 BTU/cu.ft. & a minimum price of 55¢/M	0.754
Fuel Oil - assumed at 30°Be and 7.286# per gal. & priced @ 5¢/gal.	0.229
Coal - assumed at 10,500 BTU per lb. and priced at $1.42 per net ton	0.068

The above data and prices, excepting those indicated as assumed, were supplied by Mr. G. DuBois in his letter to E.H.Buford and dated May 7, 1955.

(The average price for 1,000 BTU natural gas at Anniston is $0.205/M cu. ft. or $0.205 per million B.T.U.)

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In this matter of heat, the guiding principle should be the cheapest fuel that can be cleanly handled and whose burning equipment can be so controlled as to maintain fairly close temperatures in the preheater or preheaters and very close temperatures within the converter pot. It is believed that fuel oil would most nearly meet the above specification.

At Anniston we have fired with both fuel oil and natural gas. At present, our firing is with natural gas, fired tangentially around the pot and through 8 high pressure burners on both second preheater and converter. There are 2 high pressure burners on the first preheater. The settings opposite the lead bath are radiant and have accomplished a very nearly perfect heat application.

Whatever type of fuel used, it would be desirable to attain a similar radiant setting. From our past experience with oil firing we have found this to be difficult, and with a production less than we have attained with natural gas. Firing with oil will somewhat increase the maintenance on the pots.

It is believed that next to gas(which is eliminated only on account of its high cost), fuel oil would make for the cheapest cost. Great care must be exerted in the design and application of such fuel oil firing equipment in order to attain the desired production with a minimum of maintenance costs on the pots.

ITEM 1.1.4 - SETTINGS

The settings for these pots should be of steel plate and shapes and supported on suitable foundations. The steel setting should be lined with a combination of refractories and insulating brick or lined with insulating refractories. In the past we have used a first quality firebrick which was backed by natural sil-o-cel. The temperatures of these shells average 85°C, which represent but small heat losses. Such linings should be satisfactory unless such temperatures would make for personal discomfort.

The insulation over the top of the pots should be steel platework lined with sil-o-cel and designed for quick removal and replacement.

ITEM 1.1.5. - AUTOMATIC CONTROL EQUIPMENT

Automatic temperature recording and control equipment is very necessary. We have found Wilson-Maeulen equipment very satisfactory. Similar equipment by other manufacturers would be equally as satisfactory.

The temperature of the lead in each pot and also the vapors from each pot are recorded by means of pyods and a six point Wilson-Maeulen Tapalog. The control is through the pyods in the lead bath which are also connected to Wilson-Maeulen potentiometer controls which actuate American Radiator Company's motor operated valves on the high pressure natural gas lines to the second preheater and converter. There is no temperature control device on the first preheater for such is largely heated by the combustion gases leaving the settings of the second preheater and converter. On the first preheater are two high pressure burners which are manually operated and are used as conditions may warrant to boost the temperature of combustion gases from the settings of the other two pots.

The firing on the second preheater and converter is by gas directly piped and for minimum requirements and without regulation. Additional gas to maintain constant temperatures in the lead is passed to the same burners by the Wilson-Maeulen control operating the American Radiator two point valves, that is open or closed.

Controls to hold constant temperatures in the two hottest pots would be required whatever was the type of fuel used.

The flow of benzene to the unit is maintained at a fairly constant rate by means of a Schutte & Koerting Rotameter and manual operation of a throttle valve on the liquid benzene feed line. The success of such an arrangement depends on a pump with unvarying delivery. As we have found such an arrangement so satisfactory, it is recommended that such an installation and practice be continued in the new plant.

ITEM 1.1.6.- PIPING & VALVES

All piping for carrying the heated vapors between the inlet to the first preheater and the discharge from the lead trap, whether submerged in lead or elsewhere is 18% chromium and 8% nickel. Connections are either welded or else by welded flanges with tongue and groove joints with gaskets of steel and asbestos and made by the Goetze Gasket & Packing Company. The inlet vapor piping to the converter and the piping between the converter and the lead trap should permit of readily dismounting for access to the interior of the pot or else cleaning the hard and dense carbon adhering to the piping between converter and trap.

Up until now we have never used valves on the pipe lines for handling the heated benzene or benzene-diphenyl mixtures. Elsewhere gate valves are used in pipe lines conveying the cold solutions.

DIPHENYL CONVERTER - OPERATION

ITEM 1.2.1. - TEMPERATURE AND RATE OF OPERATION

We have operated our unit over a considerable range of temperatures. In general, the lower the temperature, or down to about 750°C, there is but little conversion. At temperatures of 860°C, the conversion is about 30%, of which 70% is diphenyl and 30% is high boiler.

These tests caused us to operate with the vapors around 840°C with a conversion of 18% of which 78% is diphenyl and 22% is high boiler, and which we calculated would make our diphenyl requirements at the cheapest cost.

As the high boiler is with only a limited market, its minimum production would be desirable. This can be attained by lower temperatures and a lower conversion per pass. The benefits of such a reduction in high boilers produced must be offset by the extra processing costs.

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As to the rate of operation of our present equipment, we know it has a daily capacity of 3,000 lbs. per day with a conversion of 18% per pass. The above production could be maintained with a faster feed of benzol, lower temperatures and a lower rate of conversion per pass, but at what economy is not known.

DIPHENYL CONVERTER

DETAILED DISCUSSION OF SUGGESTED TWO POT UNITS

ITEM 1.3.

Fuel firing, oil, or coal, is indicated by its lower cost, as shown in the comparison given in this report. For the maximum utilization of heat, a heat exchanger is demanded to recover the heat in the flue gas. In this case experience has shown that vaporization and slight super heating of benzene is a satisfactory method of recovering the heat in the flue gases. On the present diphenyl converter unit the flue gases are discharged at 255°C. In the proposed unit the flue gases are to be discharged at 200°C.

Continuous fractionation of the reaction products offers possibilities of lower cost equipment, less off-grade products, heat economy, lower losses of material, and lower labor costs. Utilization of the heat in the reaction products for the operation of the continuous fractionating columns is one method of obtaining maximum heat economy.

The suggested diphenyl unit is shown as a diagrammatic flow sheet in Drawing No. So-2403.

Heat Supply

All heat is supplied to two lead pots fired independently and controlled automatically by the lead temperatures. From the information supplied on St. Louis fuel costs, fuel oil is recommended as the cheapest, except coal which offers complications of handling and control. The flue gases leaving each pot are combined and passed through an insulated stack containing a vaporizing and superheating coil for benzene. The flue gases are discharged to waste at 200°C

The heat balance, shown also on Drawing No. So-2405, is based on the flow of 981 lbs. of benzene per hour which gives a calculated production of 5,540 lbs. of diphenyl per day. It is also based upon natural gas as available at Anniston. Oil firing should make no appreciable difference.

The total heat supplied is 715,[illegible] P.C.U. (pound Centigrade Units) per hour as compared with 1,151,940 P.C.U. per hour for the present unit or 62%. It should be noted that in the present unit additional heat is supplied for the fractionation of products in the form of steam in the benzene still and gas in the diphenyl still.

__Flow of Materials__

Liquid benzene at storage temperature is pumped through the vaporiser and superheater coil located in the stack where it is converted into vapor and superheated to 221°C. The benzene vapor passes through the heat exchanger where its temperature is raised to 465°C. From the heat exchanger it passes to the first lead pot containing lead at 720°C where the temperature is raised to 655°C. The benzene vapor at 655°C then enters the converter pot containing lead at 845°C. In the converter pot the reaction to diphenyl and high boiler occurs and the reaction gases are discharged at 788°C. The gases are considered to reach an actual temperature of 851°C at the surface of the lead but due to unavoidable heat losses are delivered through the lead trap and cyclone carbon trap to the heat exchanger at 788°C. The reaction gases leaving the heat exchanger at 515°C pass to the reboiler of the diphenyl column, supply heat for the fractionation and distillation of diphenyl, leave at 585°, enter the reboiler of the stripping column, leave at 552°C and enter the heat exchanger of the reboiler of the benzene column. The gases leave at 350°C and go to the condenser where the benzene and converted product mixture is condensed and from which the hydrogen is separated.

The liquid at 84°C flows into the benzene column in which the benzene is distilled off and returned to the benzene feed tank. From the bottom of the column a mixture of diphenyl, high boiler, and the impurities present in small amount and containing a trace of benzene is discharged as liquid at the boiling point of 255°C and flows into the stripping column.

In the stripping column the trace of benzene together with the impurity which boils somewhere between benzene and diphenyl is distilled off together with a small amount of diphenyl. The liquid from the reboiler at 260°C flows into the diphenyl column.

The diphenyl column separates the diphenyl from the high boiler; the diphenyl distilling from the top as purified material ready for sale or production of other products and the high boiler discharging from the reboiler at its boiling point 580°C.

It should be noted that the flow of the hot reaction gases is strictly counter-current to the liquid products being fractionated.

Heat Balance (Refer to Drawing No. 80-2405)

As has already been pointed out the gas consumption is 82% of the present requirements. The stack losses of the proposed unit are reduced to 11.7% as compared to 17.7% for the present unit. This percentage reduction is obtained by lowering the exit temperature from 255 to 200°C. The actual saving in heat is greater than this due to the smaller amount of flue gases; the stack loss for the proposed unit being 85,770 P.C.U./hr. as compared with 205,660 P.C.U./hr. for the present unit.

The vaporizer and superheater coil in the stack is planned to absorb 172,810 P.C.U. per hour, instead of 157,220 P.C.U./hr., as at present and raising the benzene vapor to 221°C. This is accomplished by the installation of additional heat transfer surface and the higher temperature of the flue gases leaving the lead pots. The loss by radiation and convection from the stack and flues is reduced from 140,450 P.C.U./hr. to 40,000 P.C.U./hr. by insulation.

The heat exchanger operating on the hot reaction gases and heating the benzene vapor from 221°C to 465°C recovers 155,750 P.C.U./hr., which is more than the heat usefully absorbed in the preheater No. 1 lead pot of the present unit, absorbing 107,420 P.C.U./hr. The high temperature difference existing in this heat exchanger requires only a few square feet of heat transfer surface. The small size makes possible the reduction of heat losses to a very low figure.

The heat input to the first lead pot of the proposed unit is considerably less than that of the second pot of the present unit. The second pot of the proposed unit receives approximately the same heat as the present third or converter pot. The total useful heat received by the benzene vapors in the two lead pots is slightly less in the new unit than in the present one. This result is obtained by insulating the lead pots against heat loss to a much greater extent than is done at present and feeding vapors at higher superheat. Several small changes in construction are necessary to make this possible.

The minimum temperature in the reboilers of the fractionating columns is 255°C in the benzene column. The calculated amount of reboil heat including losses for the three fractionating columns was 177,000 P.C.U./hr. In order to keep the temperature differences high in the reboilers the minimum temperature of the reaction gases leaving the benzene column reboiler was selected as 550°C. This also serves the purpose of giving a reserve heat supply of 40,000 P.C.U. per hour in the reaction gases above 280°C, which is still a high enough temperature for heat transfer. The heat exchanger was designed to absorb the heat in the reaction gases from 785°C to 615°C leaving the proper amount for fractionation purposes.

The heat in the reaction products from 550°C to the condensing temperature and the latent heat of the condensing products are wasted since it is believed that the separation of the hydrogen will make the fractionation easier. If the presence of hydrogen does not affect fractionation too adversely, there is an additional supply of heat available.

<u>Equipment</u>

In no case has the equipment for the proposed unit been detailed. The following construction notes are recorded to supplement Drawing #2405.

The first or preheater pot will be made of Crucible Steel Company's Resistal No. 7, or equivalent, with the cover welded on, replacing the present bolted construction. This enables the head of the pot to be lagged.

The second or converter pot will be made of Crucible Steel Company's Resistal No. 7, or equal, cast steel cover bolted on and all insulated and which has been previously described.

The heat exchanger would be constructed of steel or possibly nickel-chrome steel and will be arranged so that the hot gases pass through the inside of the tubes and the colder benzene vapors pass over the outside of them.

The heat exchangers on the bottom of the fractionating column will be of the same type, hot gases inside of the tubes and the boiling liquids outside.

All columns will be of the packed type, the benzene column using 1/2" Raschig Rings and the others 5/8".

The vaporizer and superheater will be made of coiled pipe in an insulated stack. A solid core in the stack will be used to obtain high flue gas velocity. The casing should be of the split type as previously described.

The setting and firing equipment for the pots would be designed to meet the fuel selected, gas, oil, or coal.

Possible Operating Difficulties

It is anticipated that there will be some difficulty in the initial starting of a diphenyl unit such as is proposed, particularly in regard to the balance of the heating surface of the fractionating columns and the position of the feed to the columns. After the equipment is in adjustment it should give no more trouble than the present equipment. There may be a tendency for carbon to collect inside the tubes of the heat exchanger in spite of the cyclone traps. This carbon will probably be hard and should not decrease the heat transfer much. Arrangements would be made to make it easy to clean out these tubes.

Basis of Design

The heat balance is based upon the assumption that the specific heat of the benzene vapors and reaction gases are essentially the same and is given by the equation:

$$c_p = 0.258 + 0.000875 \; t(^\circ C)$$

The preliminary equipment design is based upon the foregoing specific heat and upon the usual heat transfer coefficients applying to similar problems.

The validity of these relationships has been partially verified by data furnished by the Dow Chemical Company on their diphenyl unit in connection with the patent suit.

The fractionation calculations have been made using Raoult's Law in the case of the benzene column, and experimental data for the diphenyl column. These data are not as complete as could be desired.

It is recommended that development work be done to verify the specific heat, heat transfer, and fractionation relationships before the final design and installation of the equipment should the suggested type of continuous separation be adopted instead of the batch operations in use at present. This development work need not be expensive or lengthy. DSW 001303

__Savings__

The combination of two lead pots, a heat exchanger, and continuous fractionating equipment using the heat in the gases, as has been described, gives the lowest calculated operating cost. This represents a saving of 0.54 cents per lb. over our present practice. $3,400 per year

The combination of two lead pots, a heat exchanger and replacement of the present benzene still by an improved continuous column gives a calculated operating cost 0.06 cents per lb. more than the design using continuous fractionation equipment.

In these calculations no reduction in labor costs have been assumed because of the difficulty and uncertainty of arriving at a reliable figure. There seems to be little hope of reducing labor costs with the present type of equipment whereas the continuous type of equipment definitely offers such a possibility.

On a production of 1,000,000 lbs. of diphenyl a year the suggested equipment, shown on Drawing Sc-2405, would save $ 5,400.00 per year.

CMM/jw
6/25/35

DSW 001304

ADA 000657

POSSIBLE AVAILABILITY OF NATURAL GAS AT ST. LOUIS

This is written after the receipt of Mr. Livingston's letter of June 24, relative to natural gas and directed to Mr. Hawn, and also after writing our recommendations, at which time we did not know that natural gas might be available.

It is interesting to learn that you now have excellent prospects of buying straight natural gas (1,000 BTU) at East St. Louis for 30¢ per 1,000 cu. ft.

For the firing of the diphenyl converter unit, natural gas affords a nearly perfect application of heat.

Natural gas costing 30¢ per 1,000,000 BTU with its high efficiency and ease of handling and burning would probably be well in line with fuel oil at 22.9¢ per 1,000,000 BTU with its lower efficiency, greater expense of handling, storing and burning and the accompanying greater cost of maintenance on the lead pots.

As to the monthly gas requirements, we refer to our May, 1935, production of 89,000 lbs. of diphenyl. Using the average gas cost per pound of diphenyl produced for 1935 up to June 1st and an average price of gas at 20.5¢ per 1,000 cu. ft., the monthly gas requirements are 149,000 cu. ft. About 90% of this gas is used on the connector unit and the balance for distillation purposes.

If the suggested two pot unit with heat exchangers, and continuous separation devices, are installed, a monthly production of 89,000 lbs. of diphenyl would require 83,000 cu. ft. of gas.

The matter of natural gas pressure is of much importance. All of our burning equipment on the diphenyl converter unit, stills, etc., are of the high pressure type which require natural gas under a service pressure of 25 lbs. per sq. inch.

SEPARATION OF PRODUCTS - PLANT DESIGN

ITEM 2.1.1. - EQUIPMENT FOR SEPARATING BENZOL-DIPHENYL-HIGH BOILER MIXTURES

The vapors leaving the converter unit enter a fractionating column, which removes some of the diphenyl and delivers a mixture of 50-75% converted products and benzene to storage tanks prior to distilling for the further removal of the benzene. There is a still for distillation of diphenyl and also a still for refining the high boiler. Excepting the one fractionating column, all operations are batch. There seems to be no good reason why such distillation could not be made continuous. With large production, the desirability of continuous operation would be more apparent than on operations as limited as at present.

ITEM 2.1.2. - STORAGE OF BENZOL-DIPHENYL-HIGH BOILER

We have no special advices relative to the storage of benzol, diphenyl and high boiler. At present we store the benzol and high boiler in overhead cylindrical tanks and with entire satisfaction.

The liquid diphenyl from our still is caught in rectangular pans, where it solidifies and is then dumped out, broken and packed into containers, either for shipment or for further processing. A better arrangement for handling the diphenyl would be to flake on a chill wheel or in a storage tank, insulated and with steam coils.

RECOMMENDATIONS

ITEM 5

To best comprehend the flow of heat in the converter unit, a heat balance was recently made and a copy of which is made a part of this report. This heat balance will not be discussed here, except to point out means of obtaining greater heat economy in the new plant.

It would seem that fuel oil would most nearly meet the conditions as set out in Item 1.1.5. The combustion gas leaving the pot settings should be more fully utilized in vaporizing the benzene and superheating the vapor. This can be attained by insulating the setting of the heat exchanger and also building the exchanger of such an area that the utmost in superheat can be imparted to the incoming benzene vapors. The insulated case on this receiver should be of the split type, such as we use on the diphenyl still, in order that it can be opened up quickly at times of shut down, benzol failure or otherwise, and thereby prevent damage to the heat exchanger. Such a split use makes the coils of the exchanger readily accessible for inspection or repairs.

The tops of the pots with all connecting piping should be thoroughly insulated.

There is a large amount of heat in the vapor leaving the converter unit. A suitable exchanger will save part of this heat by further increasing the superheat in the incoming benzol vapor and thereby reduce the fuel requirements. Such an exchanger is recommended.

From the partial costs as shown in Item 1.1.1., the selection of the equipment narrows down to either Arrangements No. 2 and No. 3 with the benzol still eliminated or else Arrangement No. 5.

Of Arrangement No. 2, it can be said that it is the old three pot converter unit, addended by the heat exchanger and with the column changed so as to eliminate the benzol still. The system would be continuous except for the separation of the diphenyl and high boiler which would be done in batch equipment. In this design there is little of the experimental and would make for a good operating plant.

Arrangement No. 3 is the same as No. 2 but with one of the lead pots eliminated. The economies between the two arrangements are slight.

It would seem that a decision between the two would have to be deferred until the fuel and firing equipment had been worked out. If the present three pot setting can be converted to the new fuel with but little change, Arrangement 2 should be used. On the other hand, if new settings are required for proper firing, then Arrangement 3 should be followed.

Arrangement No. 5 is designed for the ultimate in heat economy and for the continuous separation of the benzene-diphenyl-high boiler. The heat efficiency of the unit would be 80% as compared with 45% attained at Anniston at present. A further use of the heat in the vapors would be to attain the desired continuous separation in columns. We have never attempted such separation but cannot see a single reason why it would not work. Before such an installation is made, it is recommended that suitable development work be done prior to the final designs.

Should a production greater than that of the present unit be desired, and in combination with continuous separation, such might be attained by two or more sets, each of two lead bath pots, and connected to a single set of columns.

High boiler, its disposition or purification has not been previously discussed. It is believed that whatever of the refined product is desired, that it can best be made on the batch still that we are using at present.

CRMcC/jw
6/27/35

DSW 001308

ADA 000661

NOTES ON A PLANT FOR THE MANUFACTURE OF THE AROCLORS (CHLORINATED DIPHENYL)

The following relates to the present plant and its operation.

Capacity

Aroclor No.	Capacity per Chlorinator per Month
1142	209,000 lbs.
1148	204,000
1154	175,000
1160	172,500
1162	172,500
1168	152,000
1169	156,000
2565	142,500
4065	142,500
5060	151,250

There are three chlorinators as shown on Drawing #C-6652. Each of these is reserved for certain compounds, namely No. 1 for 1168 and 1169; No. 2 for 4065, 5060 and 2565 and No. 3 for 1142, 1148, 1154, 1160 and 1162.

The No. 1 chlorinator can be operated continuously. Chlorinators No. 2 and 3 cannot both be operated at the same time as chlorinators. The present practice is to chlorinate in one while the other serves as a catch tank.

The monthly capacity of the plant would be the capacity of chlorinator No. 1 making Aroclors #1168 and 1169 either singly or in combination plus the capacity of Chlorinators No. 2 or No. 3 operating singly to produce those Aroclors, alloted to the individual chlorinator, either singly or in combination.

Chlorinators

The following description can be most easily followed by referring to Drawing #C-6652, Diagrammatic Layout of Chlorinating Equipment. The chlorinating equipment in use at the present time consists essentially of three 5 ft. in diameter x 16 ft. steel shells set vertically. Each shell contains a catalyst mass of iron turnings enclosed in a 27" diameter by 8 ft. long steel sleeve. A coil of 1" wrought steel pipe is provided in the annular space between the catalyst sleeve and chlorinator shell. This coil is connected to use either steam or water as required.

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Chlorine is fed into the bottom of the chlorinator directly beneath the catalyst mass. The rising gas causes circulation of the charge. A centrifugal pump is provided for each chlorinator for additional circulation which withdraws material from the bottom and delivers it to the top. Each chlorinator is reserved for a certain class of products, one for 1168 and 1169, another for 4065, 5060, and 2565, and the third for 1142, 1148, 1154, 1160 and 1162. This is a very necessary precaution since the catalyst mass is almost impossible to clean and mixing one Aroclor with another is detrimental to quality. This is particularly true of mixing even slight amounts of the crystalline Aroclors #1168 and 1169 with the others.

The chlorinator for 1168 and 1169 is provided with an emergency internal chlorine supply pipe since continuity of operation on this material is almost essential.

Mixing Tank and Traps

The chlorinator for 1168 and 1169 is used dependently of the other two and is provided with its own trap and melting tank. Only one of the other two chlorinators is in operation at a time, the other being used as a trap. One melting pot serves the other two chlorinators.

Blowing Tank

A blowing tank equipped with a steam coil and air distributor is provided for all chlorinated products except 1168 and 1169. The air blowing removes the HCl. The melting point of Aroclors #1168 and 1169 is too high to permit air blowing in a steam heated tank.

Chlorine Supply

Chlorine is received in liquid form, at the present time, and is converted to vapor as needed in a steel tank heated by hot water.

HCl Disposal

The necessary piping is provided for HCl gas from the chlorination which is passed through a trap and then to the HCl absorption system.

Product Storage

At the present time all products are drawn off into steel drums for storage prior to further processing or shipment. This method of handling is very unsatisfactory because of the large amount of fumes released.

Valves

In general all valves on the chlorine or HCl lines are lubricated Merco-Nordstrom plug cocks with screwed connections and valves on the liquid lines are all iron clip type gate valves. All equipment in the chlorinator step is steel or iron.

Insulation

The bottom half of the chlorinators is lagged with 2" of 85% magnesia. The blowing tank and melting tank for materials going into Aroclors #1168 and 1169 are insulated in the same way.

The pipe lines from the two melting tanks and the lines to the blowing tank are steam jacketed.

Drawings

The following drawings of the present chlorinating equipment accompany this report:

Layout of Chlorinators	#C-6855
Diagrammatic Layout of Chlorinating Equipment	#C-6852

The following relates to the suggested new plant and its operation.

Chlorinators

The present chlorinators work very satisfactorily. It is suggested that the present three chlorinators be used in the new plant, unless the requirements are very large, and it was decided that a few larger units were preferred to a larger number of units of the present size.

DSW 001311

ADA 000664

Mixing Tanks and Traps

It would be very desirable to provide each chlorinator with its individual trap. Such would enable each chlorinator to operate continuously on its allotted compounds. The production of Aroclors #1169 and 1168 would remain the same as at present but the production of the other Aroclors would be twice as great as it is at the present time.

The HCl from each trap would then pass to a common trap before passing to the HCl absorbing system. These traps are of an improved design and are arranged to drain by gravity to a catch tank or to the diphenyl measuring tank.

The HCl from each trap then passes to a common trap before passing to the HCl absorbing system. These traps are of an improved design and arranged to drain by gravity to a catch tank or to the diphenyl measuring tanks.

Two diphenyl measuring tanks are provided and the present melting tank for 1168 and 1169 is recommended as a catch tank. This involves the installation of an additional pump.

Blowing Tank

The present tank is satisfactory for use. If a new tank were to be installed a bumped bottom would be recommended.

Chlorine Supply

It is assumed that gaseous chlorine would be available at St. Louis and the vaporizer is omitted.

HCl Disposal

The use of a trap for each chlorinator simplifies the piping to the HCl absorber. The HCl gas obtained contains a small amount of organic matter which should be removed for the production of the highest quality HCl.

DSW 001312

Product Storage

Products are expected to be stored in tanks or bins in the place of drums as at present. This involves the installation of an additional pump for the blowing tank.

Valves

Merco-Nordstrom lubricated plug cocks will be used on all vapor lines and all iron gate valves on liquid lines as before.

Insulation

All tanks and traps should be lagged with 2" of 85% magnesia. The bottom half of the chlorinators should be lagged as before with 2" of 85% magnesia.

The pipe lines to and from the diphenyl melting tanks, the catch tank, and the pipe lines from the chlorinators to the blowing tank will be steam jacketed.

Drawings

Suggested Layout of Chlorinators for St. Louis Sc-2404.

CMM/jw
6/25/55

NOTES ON HCl ABSORPTION EQUIPMENT

Present Equipment

The HCl absorbing equipment is essentially the usual fused silica absorbers in which the HCl gas is dissolved in water and the heat dissipated. The installation is designed principally as a means of disposing of the HCl which is formed in the chlorination although, of course, the hydrochloric acid is sold whenever possible.

The HCl gas leaving the final trap of the chlorination equipment is carried by a 2" iron pipe line to a horizontal 15" O.D. x 48" steel drum which serves to settle out some of the organic matter and solid impurities. The gas then passes through a 6" steel pipe to the bottom of a vertical steel cooler and filter 24" O.D. x 67" high which is filled with coke. A riser of five lengths of 6" bell and spigot terra-cotta pipe, approximately 10 ft. high carries the gas to the fused silica absorbers.

The connection between the terra-cotta pipe and absorbers is made by two lengths of 7" O.D. bell and spigot, silica pipe forming a trap with drain which leads to the pyrex cooler.

The HCl gas passes in series through 15 silica absorbers arranged one on top of each other. At the top absorber water is added which flows counter-currently to the gas and is finally discharged as hydrochloric acid from the silica pipe connecting the absorbers with the terra-cotta riser. The hydrochloric acid flows through a cooler consisting of 8 - 1" Pyrex tubes water jacketed for 4 ft. each arranged in series and is discharged into a small brick lined catch tank or box. The cooled acid then flows by rubber lined pipe and valves to a rubber lined steel tank of 20,000 gallon capacity.

The gases leaving the top of the silica absorbers is carried by 6" terra-cotta pipe to the base of a drowning tower 18 ft. high, constructed of terra-cotta bell and spigot sections 24" O.D. The drowning tower is filled with coke and is supplied with water which overflows at the bottom to a drainage ditch. A Duriron fan is located at the top of the drowning tower to pull the gases through the HCl absorbing system.

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It seems to be practically impossible to keep this equipment tight with the result that hydrochloric acid of various strengths is spilled over the various pieces of equipment. To protect the steel supporting structure and the steel equipment, it is covered by a heavy coat of tar. This seems to work very well.

The hydrochloric acid made is yellow in color and contains a small amount of organic matter. Samples of this acid have already been sent to Monsanto Laboratories in St. Louis for examination.

Proposed Equipment

It is understood that it is planned to combine the HCl from the chlorination of diphenyl with HCl derived from operations already operating in St. Louis. Accordingly no plans have been made of HCl absorbing equipment for the St. Louis location.

It will probably be necessary to install some type of filtering apparatus to remove the organic impurities in the HCl before absorption. A fine coke packing will probably serve this purpose.

CRM/jw
6/25/55

DSW 001315

ADA 000668

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NOTES ON AROCLOR DISTILLATION EQUIPMENT FOR AROCLORS NO. 1242, 1248, 1254, 1260, 1262, 1268, 4465, 5465

The following notes relate to the present plant.

The equipment for the distillation of all distilled Aroclors except 1268 and 1268 consists of a vacuum, pipe-still type, apparatus without a fractionating column. For detailed description the following divisions will be used: Refer to Drawing #0-6838.

1. Melting Tank
2. Kettle
3. Quimby Pump
4. Heater
5. Foam Trap
6. Condenser
7. Receiver
8. Blending Tanks
9. Filter Press
10. Acid Scrubbers
11. Vacuum Pumps
12. Hot Aroclor Circulating System
13. Wilson-Mauelen Tapalog
14. Miscellaneous

1. Melting Tank

The melting or charging tank is of steel 3' diameter by 3' deep with a 1'1" cone bottom and holds 175 gallons. The tank is heated by a simple ring gas burner on the cone bottom. It is filled from drums lifted into position by a chain hoist, and is discharged through a 2 1/2" gate valve and pipe into a funnel containing a 40 mesh strainer. The tank is lagged with 2" of Eagle-Picher Cement No. 66 and is fitted with a tight steel cover connected with an exhaust fan to prevent escape of fumes into the work room.

2. Kettle

The kettle is a cylindrical steel tank 36" in diameter by 3' high, set vertically, with rounded top and bottom, with a distillation charge capacity of approximately 175 gallons. The head of this tank has connections for the charging pipe, vapor, drain from foam trap and superheated liquid from the heater.

DSW 001316

The charging pipe is 1 1/2" steel pipe jacketed to allow circulation of hot Aroclor 1148. Close to the kettle is a 1 1/2" Merco-Nordstrom lubricated plug cock.

The vapor pipe is 4" and is connected by a flange connection to the monel metal pipe leading to the foam trap.

The drain from the foam trap is a one inch pipe leading through the head to within one inch of the bottom of the kettle.

The line carrying superheated liquid from the heater coil is 2" steel pipe jacketed for hot Aroclor.

There is a vent pipe closed by a Merco-Nordstrom valve on the side of the kettle used for charging.

3. Quimby Pump

This is a Quimby No. 5 jacketed screw pump with a capacity of 25 gallons / minute driven at 1200 R.P.M. by V-belt drive from a 5 H.P. Motor. The pump is fed by a 2 1/2" jacketed pipe line from the bottom of the kettle. A steel gate valve is located in this line close to the kettle. The pump discharges through a 2 1/2" jacketed steel pipe which is reduced to 1" just before it enters the heating coil.

4. Heater

This consists of helical coil of 1" steel pipe 8" diameter (to pipe center) containing six turns, each turn approximately 1" from the other. The coil is placed in a cylindrical jacket and is heated by a Surface Combustion, two ring, low pressure, multiple jet gas burner of 200 cu. ft. per hour capacity. The coil is joined to the pipes leading to and from the kettle by ground joint unions. At a short distance above the union, a 1/8" pipe nipple is welded to the pipe coil. The nipple is closed by a sleeve connector and plug. This is used to sweep out the heating coil by removing the plug and allowing air to carry out the liquid as it rushes into the evacuated equipment. A steel gate valve is inserted in the line directly before it enters the heating zone.

5. Foam Trap

This is a device made of 14 gauge monel metal. It is located on the top of the kettle and is interposed in the vapor line between the kettle and condenser. Externally it is cylindrical in shape 12" in diameter and 30" high. The inner core is also of monel metal 8" in diameter and 24" high having a welded cover and a scalloped lower edge spot-welded to the base of the outer shell. At the center of the bottom of the foam trap there is a 1" pipe leading to within 1" of the bottom of the kettle. The vapor line connecting the foam trap to the kettle vapor flange is of 14 gauge monel metal 4" O.D. and enters the foam trap tangentially four inches from the bottom.

The rotary motion thus imparted to the vapor tends to separate the dark colored entrained liquid which flows under the inner core, through the one inch pipe back to the kettle. The vapor passes from the foam trap through 4" O.D. flanged monel pipe which is connected to the condenser by two 90° flanged ells. All flanges of the foam trap assembly are welded to the pipe.

6. Condenser

This is a 12 ft. length of 2 1/2" monel pipe enclosed by a jacket of 4" steel pipe. A reducing flange connects with the flanged ells at the inlet. It inclines at approximately 45° to discharge into the sight cylinder located on top of the receiver. The sight cylinder is of Pyrex glass 7 1/2" O.D. x 7" I.D. x 7" long set in two grooved steel flanges with French type Goetze lead-asbestos gaskets.

7. Receiver

This is a steel tank 30" in diameter by 36" deep. Its walls, bottom and cover are lined with monel metal. A one inch galvanized pipe line leads from the bottom of this vessel to the blending tanks. A dome of eight inch steel pipe 4 1/2 ft. high is welded into the top of the receiver. This dome is lined throughout with monel metal. The top of the dome has a 2" nipple welded in which connects through a cross to the vacuum pump line, mercury gauge and compressed air supply. The dome is for the purpose of cooling the vapor leaving the receiver and reducing the stoppage of the vacuum line by sublimate.

8. Blending Tanks.

Two galvanized iron tanks 50" diameter by 45" deep are used for blending. The product is transferred from the receiver to the blending tanks by compressed air. The blending tanks are equipped with " Lightning" agitators for mixing.

9. Filter Press

This is a 12 inch brass plate and frame Sperry press. Filter cloth backed up by Whatman No. 1 filter paper is used to treat all liquid Aroclors. The press is heated by four electric strip-heaters, two on each side. Aroclor is forced through the press by an Oberdorfer No. 7 brass herring-bone, gear pump.

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10. Acid Scrubbers

During distillation a small amount of hydrochloric acid is formed by decomposition, which must be scrubbed out to prevent damage to the vacuum pump. Two scrubbers steel 72" high by 24" diameter filled with coke soaked with 80% caustic soda solution are placed between the system and the vacuum pump. These are arranged so that they may be used alternately, to permit cleaning without interruption to distillation.

11. Vacuum Pumps

Normally the system is exhausted by a Wheeler three stage Tubejet Vacuum Pump. A Devine motor driven reciprocating vacuum pump is also installed for service whenever our small boiler is shut down.

12. Hot Aroclor Circulating System.

Aroclor 1148 is used to heat various points of the system. This is heated by gas in a tank 24" diameter by 24" deep and circulated by a 3/4" American Marsh Centrifugal Pump. Hot Aroclor is supplied as needed to the following points:

(a) Jacketed lines from kettle to Quimby pump and from coil to kettle

(b) Jacketed charging kettle
(c) Quimby pump jacket
(d) Quimby pump packing gland jacket

This hot oil circulating equipment with its open heater is of a type which should not be installed in a new plant.

13. Wilson-Maeulen Tapalog

This is a six point recording pyrometer. Two points each are used at the inlet and outlet to the coil, one in the foam-trap and one in the receiver. "Baby Pyods" (thermocouples) are used with this instrument.

14. Miscellaneous

Goetze No. 2 gaskets made of copper and asbestos are used on all of the flanged joints of this apparatus.

The discharge part of the Quimby pump is connected to a 2" Tee which in turn connects to the jacketed 2" pipe leading to the heating coil and also to a 2" iron plug-cock which serves to drain off still bottoms or residue. The present practice is to accumulate approximately 500 lbs. of still bottoms and then to maintain this amount by periodically drawing off the calculated accumulation over this value. It is strongly recommended that a draw-off be located in the side of the kettle such that 500 lbs. of still bottoms will be automatically maintained in the kettle.

Proposed Plant

It would be possible to move the present vacuum distilling equipment to St. Louis and operate it, as at present, producing both "liquid" and "solid" Aroclors with a capacity of approximately 5,000 lbs. per day.

If, however, there is the prospect of an increased demand for distilled Aroclors, then it is suggested that the present still be installed at St. Louis, equipped as shown in Drawing No. So-2406 for the production of "solid" Aroclors, and a new still be installed with a minimum capacity of 10,000 lbs. a day of the "liquid" Aroclors, as shown in Drawing No. So-2405.

It is very desirable to keep the "solid" and "liquid" Aroclors separate throughout their manufacture. A small amount of contamination of the "liquid" Aroclors by "solid" Aroclors will seriously impair the quality. This is particularly true when the contaminating material is crystalline. When the same still is used for both solid and liquid materials it must be cleaned very carefully when changing over from one product to the other. This cleaning operation is time consuming and even with the greatest of care occasional contamination will occur.

Solid Aroclor Still (Drawing No. So-2406)
For Aroclors 1268, 4465, 5460

The only changes suggested to permit the use of the present still for "solid" Aroclors alone are: the installation of a Parks-Cramer heater, or equal, with pump, etc., for the hot Aroclor 1148 to be circulated in the pump jacket, pipe jackets, melting tank, and condenser jacket. This replaces the crude outfit in use at the present; improvement of the melting tank by the use of hot Aroclor heating coils in the place of gas and a mechanical mixer; better design of Scrubber for removal of HCl from the gases going to the vacuum pump; addition of a 10,000 lbs. blending tank for "solid" Aroclors alone.

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Liquid Aroclor Still
(For Aroclors 1242, 1248, 1254, 1260 and 1262)

The design of this still is shown in Drawing #8c-2405. This drawing shows the general layout and principle features. No details of this still have been prepared.

The essential changes proposed for this still as compared to the present layout are:

1. The use of a 60,000 lb. storage tank feeding the measuring tank and still, replacing the present unsatisfactory handling of materials in drums.

2. The use of a steam heated mechanically stirred measuring tank replacing the present gas heated unstirred tank.

3. The use of an internal foam trap in the still kettle.

4. A Byron-Jackson Pump replacing the Screw Type Quimby Pump.

5. A more compact and better designed condenser.

6. A better designed receiver permitting discharge by a pump rather than compressed air.

7. A better designed and more conveniently located Scrubber for HCl.

8. Two 10,000 gallon blending tanks used solely for "liquid" Aroclors.

9. Improved ventilating system.

DSW 001321

CMM/jw
4/26/55

NOTES ON A PLANT FOR THE MANUFACTURE OF AROCLOR NO. 1260

Aroclor No. 1260 is the product distilled from chlorinated diphenyl with a chlorine content of 60%.

A brief history of these operations would probably be in order.

The first distillations were made in small steel pots fired by gas. A satisfactory product was made, but there was much decomposition with low yield.

To improve the yield, we next constructed a unit consisting of a cast iron pot with thick sides and bottom. The inside of this pot was completely machined so that the heavy plow type agitator would sweep within 1/8" of the entire interior surface. Firing was done with gas. This arrangement increased the yield but carbon building up and adhering to the shell would very often stop the agitator. This still was soon abandoned in favor of the present type of distillation equipment which gave higher recoveries with greater ease of operation.

The present still consists of a steel pot with a launder on the inside of the shell. There is a drain from this launder to the flaker (formerly to the quenching tank). The pot has a removable cover with a vent. The firing is by gas.

The suggested plans for a new plant as shown on our Drawing #8c-2407 proposes a tank, lagged and heated by circulated hot oil or one of the Aroclors, for receiving the batch from the chlorinators. Material from this tank would be fed to a flaker, from which an elevator would elevate to an overhead bin. The above drawing shows a bin of 50,000 lbs. capacity but this can be varied according to operating schedule.

The flaked material would flow to the still pot, which rests on a platform scale and from which the exact weight for a charge is determined. In a similar way, lime is added either from a bag or similar device.

An alternate way of charging the stills would be to run in molten crude from the heated storage tank. Since the chlorinators require 40 hours to produce 7,500 - 8,000 lbs. of crude and the stills have about the same capacity, some of the crude would be stored hot for about 40 hours. Crude 1168 and 1169 held slightly above the melting point decompose to some extent. Whether this amount of decomposition would be appreciable or not is not known.

Conversion of the liquid crude chlorinated material into either finished product or flaked solid form as rapidly as possible seems the most advantageous procedure. After a chlorinator batch is dumped into the storage tank the flaker would be started. As rapidly as stills became available molten material would be run into them until all liquid crude was exhausted. Stills would then be charged with flaked material.

The stills filled with a batch are elevated and conveyed to a steel setting lined preferably with insulating refractories. These insulating refractories are especially adapted to such batch operations because of their low capacity for heat. Firing may be by any fuel, use that which is cheapest and most convenient.

The material distills out and is flaked on a chill wheel from which it passes to an elevator and overhead packing bin.

In these operations, off grade product comes off at both the start and at the end of a batch run. It is necessary to divert this off grade material from the chill wheel. For this purpose we use a small vessel with spout. This device deflects the off grade product and prevents it reaching the chill wheel.

At the end of the run, the pot with coke, lime, etc., is lifted from the setting and removed to an area where it can be opened and cleaned.

All construction must be tight so that a minimum of dust contacts the operators. The room housing this equipment should be well ventilated both because the stills are hot and as an extra safeguard against dust. Operators in contact with such dust may develop a severe form of dermatitis.

These operations as above described are far from ideal. The batch requires close watching to prevent off-grade products mixing with the good product at the first and last of each distillation. This splitting is entirely dependent on the operator, his care and visual observations.

Another factor complicating operations is the sudden decomposition that occurs at the end of the distillation. The gas evolved contains large amounts of acid forming vapors and also some of the Aroclor 1260 as an extremely finely divided dust which is discolored and decidedly acid. Efforts made to collect this dust and rework it have not been successful. Our operations at present are to discharge these decomposition products through an exhauster and into the atmosphere. Such a procedure in a more populous community might create a nuisance.

A better method is desired for cleaning the coke and lime residue out of the pots. At the present time the dense, tightly, adhering mass is chipped out with bars or dislodged by pounding on the pot. The still pots scale and distort as a result of the residue and are battered by the cleaning operation. Wetting the residue has been tried but did not facilitate their removal.

Vacuum distillation has been considered but certain complications present themselves. The cleaning of such a vacuum still would be a serious problem, for if distillation were carried only to the point where the residue would run out, the recovery would be low. The material sublimes readily and any air leakage would quickly cause a stoppage by the sublimed material. Then too the hold point is very close to the boiling point under reduced pressures.

Data on vacuum distillation as done by the laboratory are as follows:-

Hold Point of Batch #192		=	241°C
Charge	356 G		
Yield	342 G	=	96%
Residue	12 G	=	4%
Total Distillation Time		=	12 mins. or 29 G/min.

Distillation Range			Actual Reading	Corrected for Stem Exposure	Pressure
1st	gram	(approx.)	240°C	245.5°C	8 min.
10th	"	"	255	256.7	7.5 "
125	"	"	255	258.8	7.5 "
275	"	"	265	267.1	7.5 "
325	"	"	264	268.2	7.5 "
342	"	"	270	274.2	7.5 "

Decomposed at end, coming over dark. Sharp rise from 265 to 270°C with little coming over.

Our layout, as shown on Drawing So-2407 makes no provision for either general ventilation of the department or for the collection and further processing of the product discharged from the still at the end of the run. For general room ventilation we would suggest disc or propeller fans. For the collection of the fine dusts, decomposition products, etc., we would recommend hoods, duct-work, collector, etc., connected to an exhaust fan.

The choice of a collector for this service is a difficult one. The material is acid and the fineness of particles approach that of fog particles. Wool cloth is quickly destroyed. To us it seems likely that the successful collector will be a scrub tower. The material caught in this tower would then be reworked to improve the yield.

MHB/jw

NOTES ON A PROPOSED ASSEMBLY OF PLANTS FOR PRODUCING DIPHENYL AND THE VARIOUS AROCLORS

A layout in plan of the above plants is shown on Drawing #8o-2402.

This layout shows a building 60 ft. wide by 200 ft. long with loading platforms and walkways on the side. The building should be of fire-proof construction with the various units separated by fire walls. There may be approved doors in these fire walls but a better arrangement would be to have the fire walls without doors but with access to the various rooms through doors leading from the side platforms and walkway.

The handling of benzene vapor at high temperatures and in equipment fired with gas, the distillation of converted products by direct fire and the storage of these products might seem to constitute a decided fire and explosion hazard. These dangers are ever present but the equipment is so designed and operations are so arranged that there has never been an explosion and only a few small fires in old equipment which has since been replaced. Over the past two years, and with equipment as installed, there has never been a fire or explosion.

The layout as shown on Drawing #8o-2402 is arranged to keep the following in mind, namely.

(1) The benzene feed tanks, which hold considerable benzene, would be in an isolated building, where if a fire did occur, the damage would be at a minimum and no damage would occur to the processing equipment.

The main storage of benzol would be located at a safe distance from the feed tanks or else under ground and so protected that damage would not occur if a fire took place in the feed tank house.

(2) The converter units are shown in one end of the building and in such a way that extra units can be installed in an additional bay of the building and thereby readily admit of future expansion. Capacity of one unit is 5,500 lbs. diphenyl per day.

(3) The Instrument and Control Room and the Diphenyl and High Boiler Storage are adjacent to the converter units, and the space allotted in the center of the building should be ample even for future and large production.

(4) The chlorinators are shown in a rather large room in which considerable other chlorinating equipment could be installed at a future time. Equipment shown dotted would enable the production to be doubled. Should the equipment shown as dotted be installed with twice the capacity of the present equipment, then the chlorinating capacity would be three times that of the present chlorinators, each with its own separate trap. (For capacity see Schedule under chlorinators) If a production, greater than that of three times three chlorinators with separate traps can be foreseen, then more building space should be allotted to the chlorinators.

A chill wheel is shown in the chlorinator room. This would flake either diphenyl from the storage tanks or else certain of the chlorinated diphenyls from the chlorinators, for either sales requirements or future processing.

(5) The distillation equipment for the various Aroclors are shown in two building sections and adjacent to the chlorinators. The space allotted would provide for a production of 180,000 lbs. Aroclor #1269, 500,000 lbs. liquid Aroclors and 90,000 of solid Aroclors, other than 1269, per month. If larger productions are now foreseen, then greater space should be allotted. Future expansion could also be attained by installing equipment in the Warehouse Section, and then building additional Warehouse space on the end.

(6) The HCl absorbers and storage for Muriatic Acid are shown outside of the building and opposite of the chlorinators. Other locations would be equally as good, and it might also be desirable to pipe the HCl gas to existing absorption equipment.

(7) We have kept in mind, straight line production with raw materials entering one end of the building and being processed in a line and finally arriving in the Warehouse.

General

We have been advised that this equipment will probably be installed in an existing building whose dimensions are unknown to us. This study is therefore submitted in the hope that it might be of assistance in laying out this equipment in your present building.

DSW 001327

EHB/jw
6/25/35

DSW 001328

ADA 000681

WATER_PCB-SD0000045848

SECTION NO. 2

NOTES ON DIPHENYL AND DIPHENYL DERIVATIVES PLANTS OPERATION, AS AT ANNISTON

BY

J. L. HOWERTON
F. M. WILLIAMS
(OPERATING DEPARTMENT)

The Drawings Referred to in This Section are:

DIPHENYL UNIT

C-6831 – Diphenyl Plant – Diagrammatic Flow Sheet of Present Plant

CHLORINATING UNIT

C-6832 – Diagrammatic Layout of Chlorinating Equipment

HCl ABSORPTION

No Drawings

AROCLOR NO. 1260

C-6839 – Layout of 1260 Plant

AROCLOR DISTILLATION

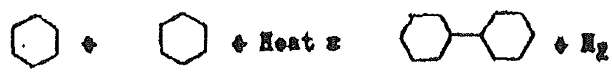
C-6838 – Layout of Badger Still

MANUFACTURE OF DIPHENYL

AS PRACTICED AT SWANN CHEMICAL COMPANY

PLANT ANNISTON, ALABAMA

Diphenyl is a polymerization product of Benzol resulting from the heating of Benzol vapor to temperatures around 800°C. It's formation is accompanied by the liberation of one mole of Hydrogen for each mole of Diphenyl produced according to the following reaction:



Diphenyl production is also accompanied by further polymerization products and some decomposition yielding ortho, meta and para-diphenylbenzene, tetraphenyl, tars and carbon.

The yield of Diphenyl and percent of conversion to higher polymers is a direct function of temperature.

The manufacture of Diphenyl as practiced at the Swann Chemical Plant in Anniston is shown diagramatically by drawing No. C-6851 attached, by actual photographs of the equipment and is described as follows:

Raw Materials
Benzol is the only raw material required for the production of Diphenyl but it is essential that a pure benzol be used. This material is bought under the standard specifications of The Barrett Company for Industrial Pure Benzol to which has been added the following specification for Feezing Point.

> "Freezing Point
> The freezing point must not be below 4.8°C, test to be made in accordance with the method of U. S. Steel Corp."

The freezing point specification has been found to be the most valuable test in determining the quality of Benzol.

DSW 001330

Past experience has shown that impurities in the Benzol tend to decrease the yield of diphenyl, increase the percentage of higher polymers and lower boiling oils.

These impurities also show up in the resulting diphenyl and cause trouble in the Aroclors subsequently made from it.

It is also strongly suspected that dermatitis among the operators is caused by impurities in the benzol.

Raw Material Handling
Benzol is received in tank cars. It is unloaded with a #8H5 Westco pump and pumped through a 1½" line to a 10,000 gallon storage tank located above ground, 500 ft. from the diphenyl building. This tank is equipped with steam coils to prevent freezing in cold weather. When required for use the benzol is pumped from this storage tank with a 1½" Viking pump through a steam-jacketed, lagged, 1½" line to one of four 750 gallon feed tanks.

Operation of the Converter Unit
Benzol is pumped from one of the feed tanks using a Westco 5K9 pump which gives a line pressure of 85 - 90#, through a 1/2" #1525 Schutte Koerting Rotameter. The flow is regulated to 125 gallons/hour through a hand operated 1/4" valve. The line pressure after leaving the control valve is 60# guage. The liquid benzol is then led through a waste heat vaporizing coil, located in an auxiliary stack to the diphenyl unit, and emerges from this coil at a temperature of 135 - 150°C. and a pressure of 50# guage. It is then led to the #1 preheater pot, which is a lead bath pot heated principally by the waste gases from the #2 preheater pot and the converter pot, bubbled through the lead and exhausted out the top. The lead temperature is held at 400 450°C and the exit vapor leaves the pot at 350 - 375°C and a pressure of 38#. The vapor is then led to a second preheating pot which is similar to the first except that this is a fired pot and is operated so as to maintain a lead temperature of 725° - 735°C. The exit vapor leaves this pot at a temperature of 625 - 650°C and a pressure of 18#. Up to and including this second preheating pot there is practically no conversion to diphenyl. This is purposely avoided because past experience has shown that any diphenyl formed prior to the last or converter pot tended to form higher polymers and carbon when put through the converter pot.

DSW 001331

ADA 000684

After leaving the second preheater the vapors are put through a third and final lead bath pot called the converter. This is a fired pot and the lead temperature is maintained at 840°C. The exit vapor leaves the converter at 725 - 750°C and a pressure of 8#.

The above mentioned lead temperatures are correct and are taken with Wilson-Maulen Pyods through temperature wells immersed in the lead bath. The vapor temperatures are also measured with Wilson-Maulen Pyods but are only relative in that the temperature wells are located in the discharge pipes about 12" above the tops of the pots and the temperature as measured is influenced by radiation, volume of gas flow, etc.

After leaving the converter pot the vapors pass through a trap where any lead carry-over or carbon is dropped out and thence to the fractionating column. At the top of this column a dephlegmator is operated in such a manner as to return all of the diphenyl, high boiling material and part of the unconverted benzol back to the column from which it is discharged at the bottom through a steam-jacketed line to one of three 750 gallon sump tanks. The temperature at the top of the column is maintained at 78 to 80°C by control of the cooling water flow through the dephlegmator.

After separation of the diphenyl, high boiling material and part of the benzol, the remaining unconverted benzol vapor and hydrogen is passed through two condensers where substantially all of the benzol is condensed. This is returned to the feed tanks and re-used.

The Hydrogen saturated with benzol vapor passes out of the last condenser to a cooler, on through into alternate chambers of a Pittsburg Lectrodryer Company, activated alumina adsorber. Here the benzol is adsorbed, the hydrogen passed on through and vented to the atmosphere.

DSW 001332

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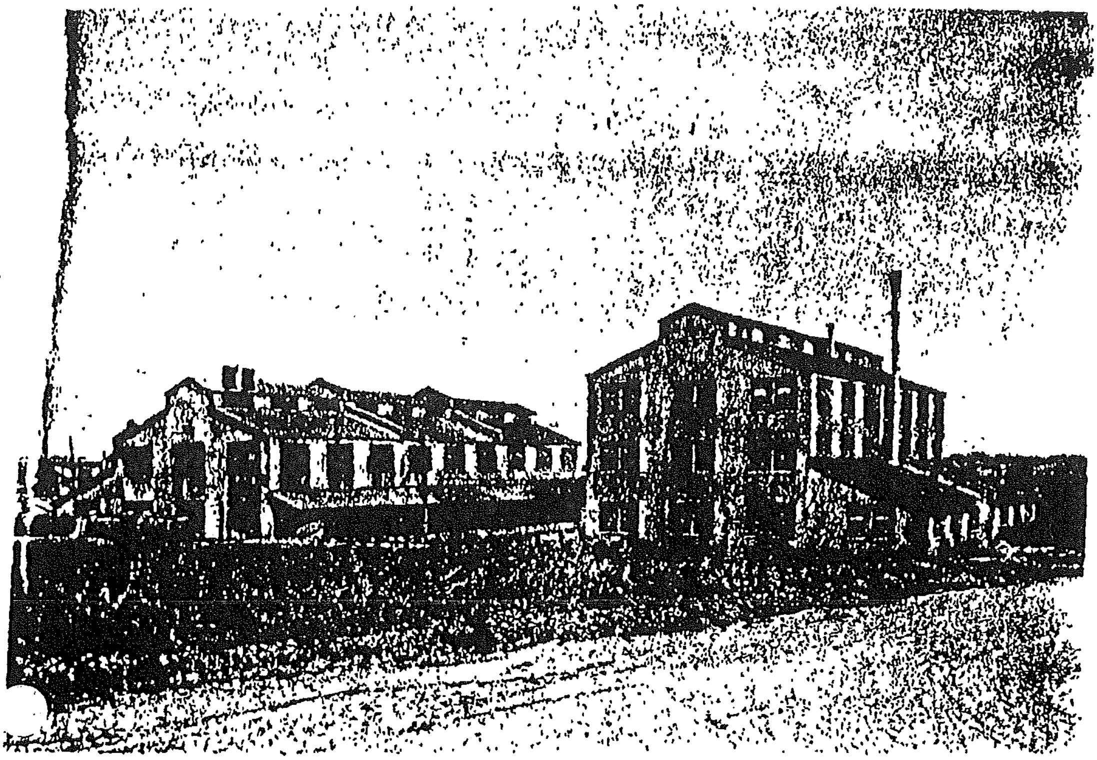
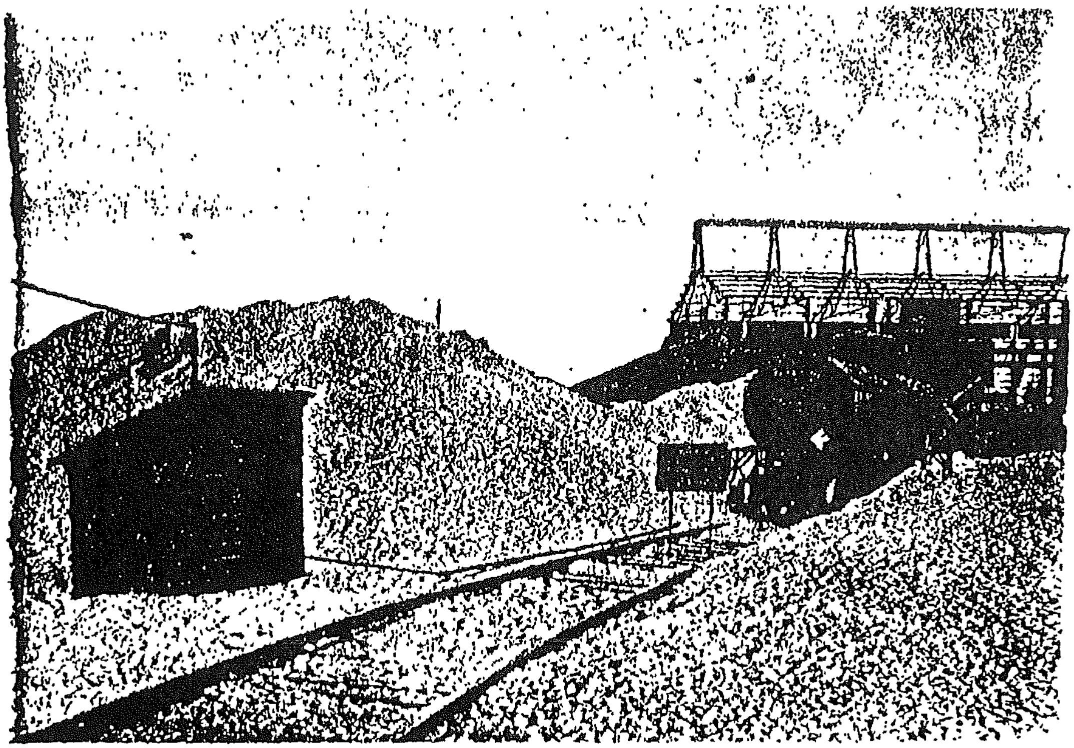


SWANN CHEMICAL COMPANY

Diphenyl & Aroclor Building left, Development Building right.

Note:
Diphenyl & Aroclor building divided into three sections by fire walls. Converter unit and chlorinators in left section, Crude Diphenyl collection and distillation center section, product storage in right section.

DSW 001333

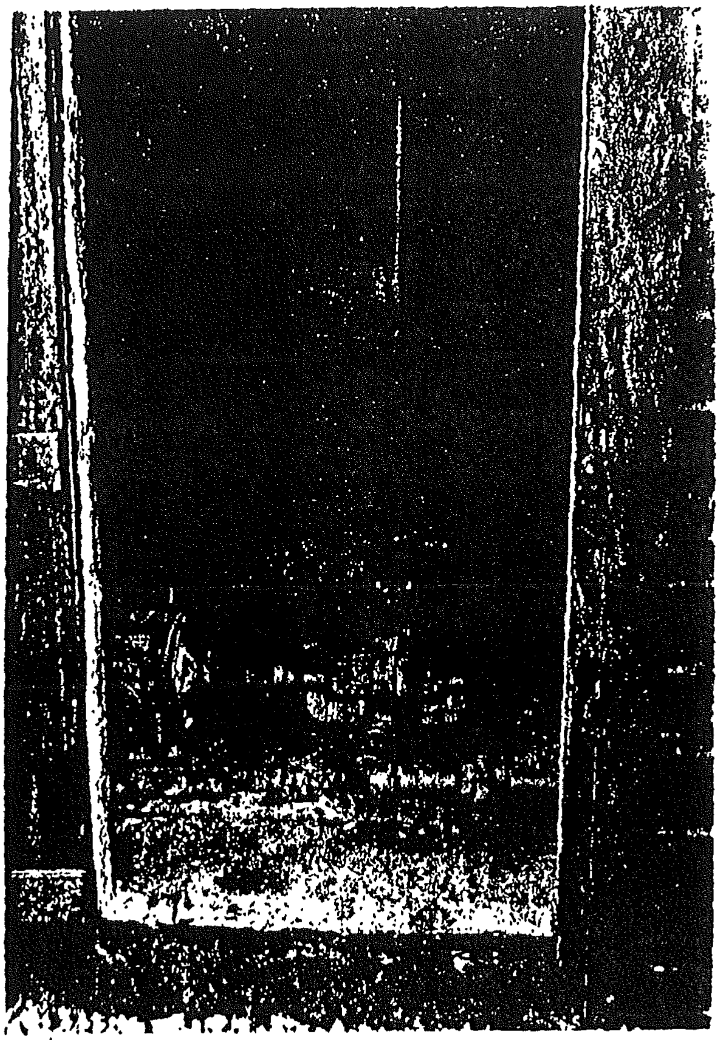


BENZOL UNLOADING

Small house contains No. 6H6 Westco Pump driven by 3 H.P. G. E. explosion proof motor. Unloading rate 2,500 gallons per hour. Pumped through two inch lines.

DSW 001334

ADA 000687

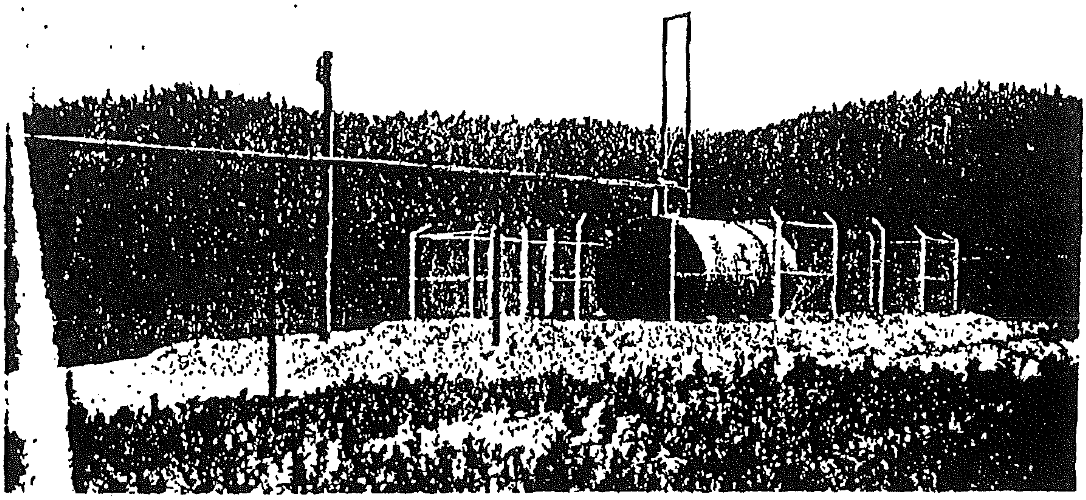


BENZOL UNLOADING PUMP

This is a #6H6 Westco Pump. Same type only smaller is used for unit feed pump.

DSW 001335

ADA 000688

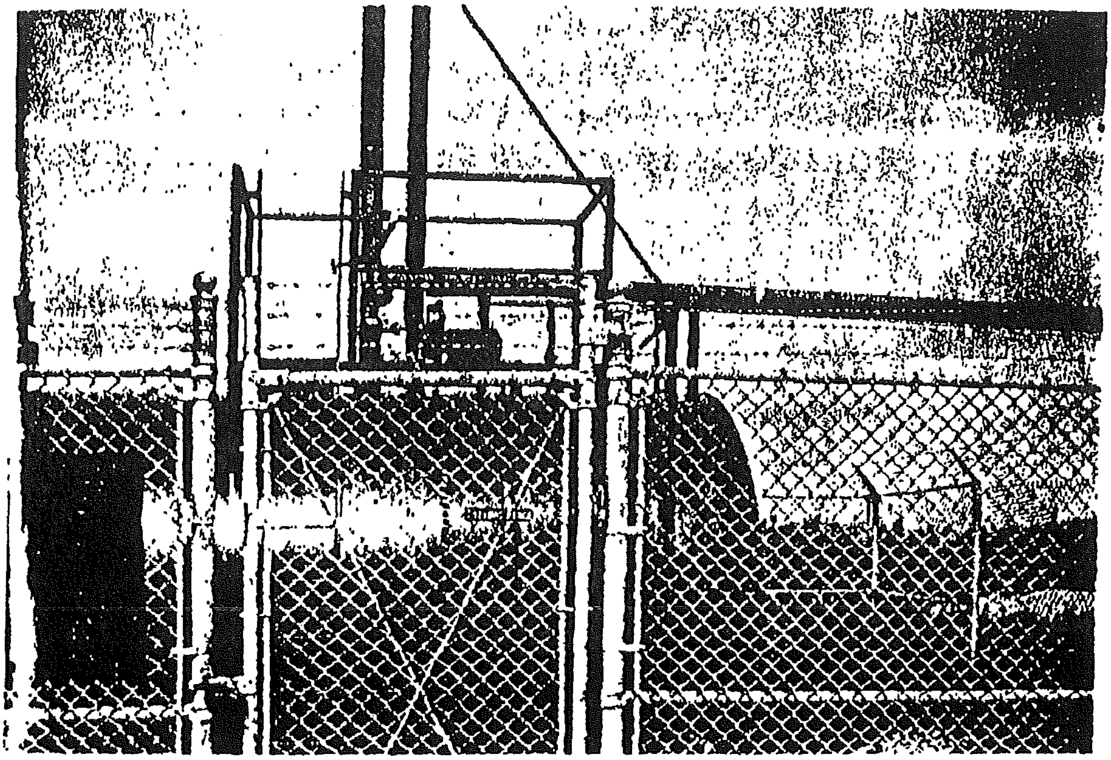


BENZOL STORAGE

10,800 Gallon Tank 10' Diameter, 18' Long Dished Heads.

DSW 001336

ADA 000689

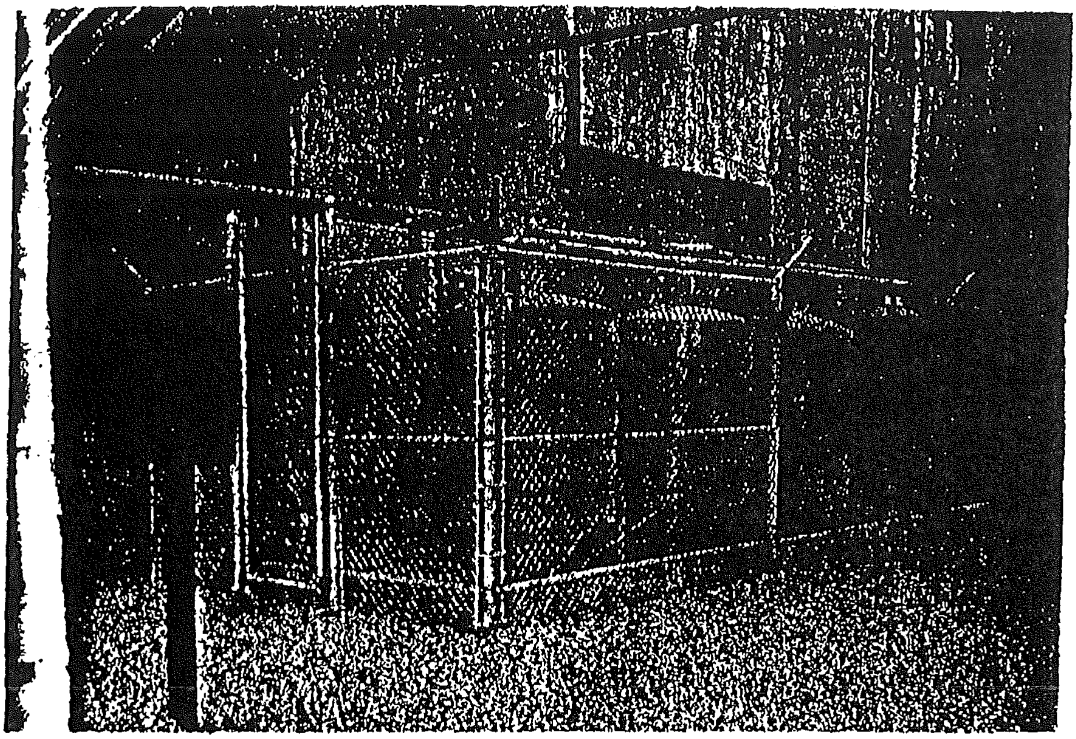


BENZOL STORAGE

Note: Pump above tank used for handling benzol to unit feed tanks. Two upright pipes same as an anti-syphon device.

DSW 001337

ADA 000690



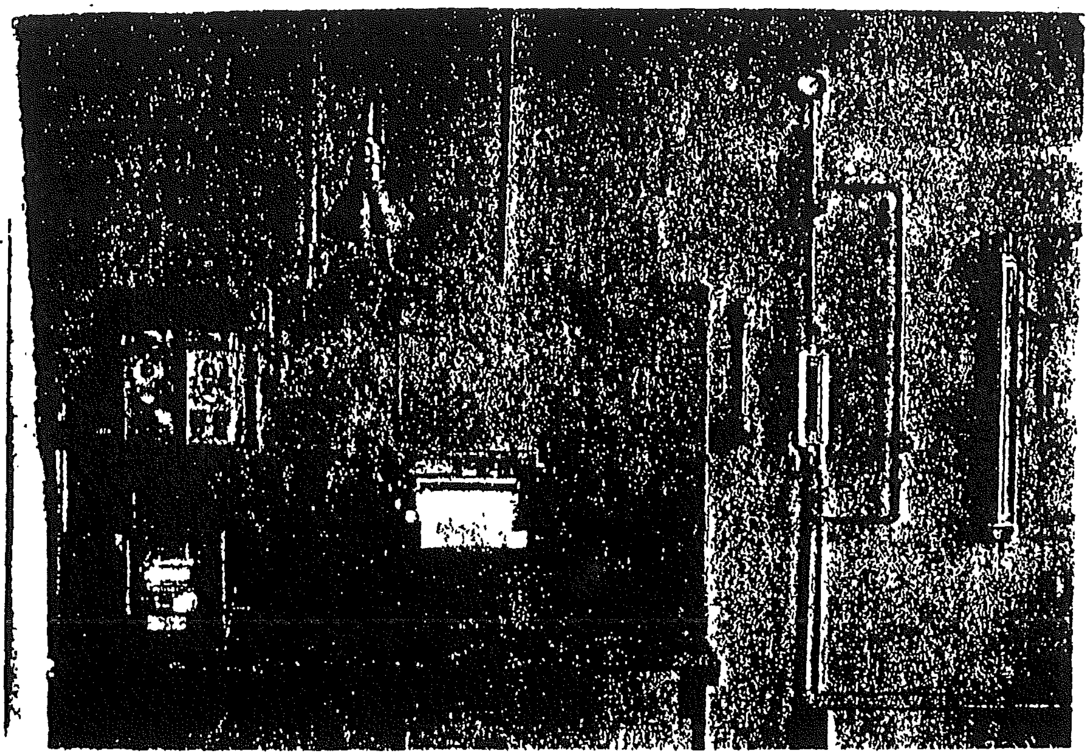
BENZOL FEED TANKS

3 - 750 Gallon   1 - 525 Gallon

Pipes overhead are supply pipes from benzol storage, return lines from benzol still and vent lines connected to Lectrodryer absorbers. Diphenyl unit feed pump is shown at left of first feed tank just inside gate.

DSW 001338

ADA 000691



CONTROL BOARD

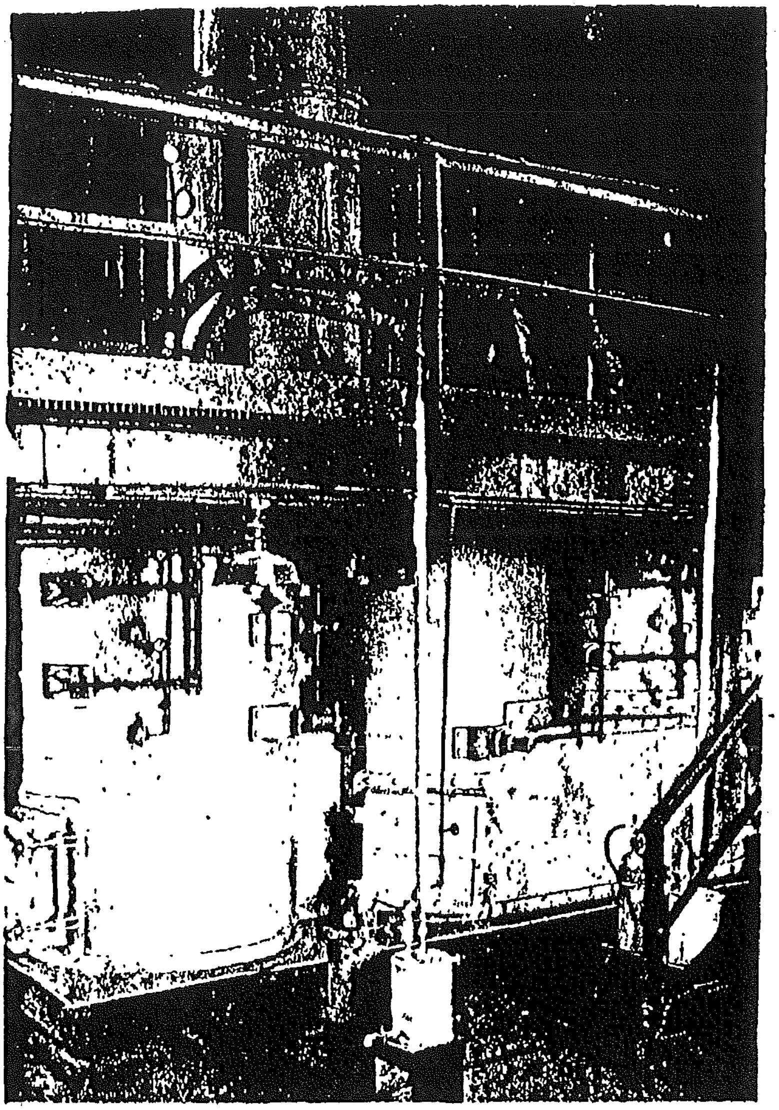
Reading from left to right.

Below - Wilson Maulen 6 Point Tapolog records unit temperatures. Above - Wilson Maulen temperature controlers. Center - Brown 6 point Potentiometer, records still and chlorinator temperatures. Right Center - Benzol feed pump switch and Shutts Koerting Benzol flow meter. Right - Wehling Tank-O-Meter, registers benzol in storage tank.

DSW 001339

ADA 000692

WATER_PCB-SD0000045859

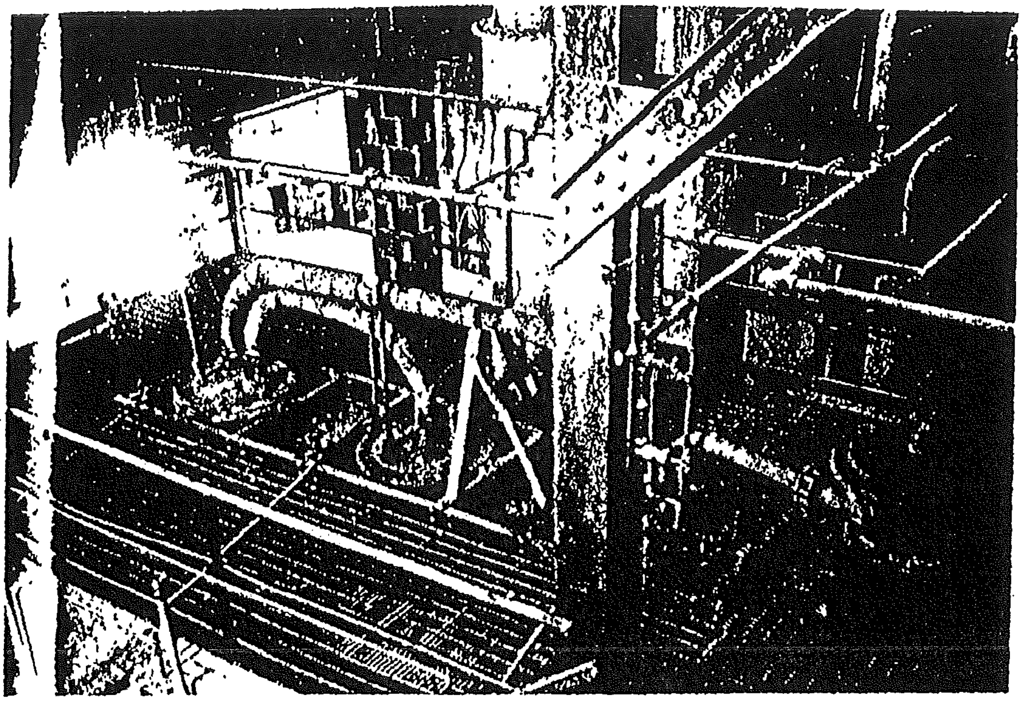


DIPHENYL UNIT

Note:
Two stacks. One in foreground used only as a by-pass when starting or stopping unit. One in background contains coil type benzol vaporizer. Products of combustion leave unit through this stack. Vapor leaves this coil and enters center pot which is #1 preheater, passes on to left pot which is #2 preheater and then to right pot which is the converter.

DSW 001340

The apparatus shown in the foreground is experimental and is not part of the diphenyl unit.



DIPHENYL UNIT

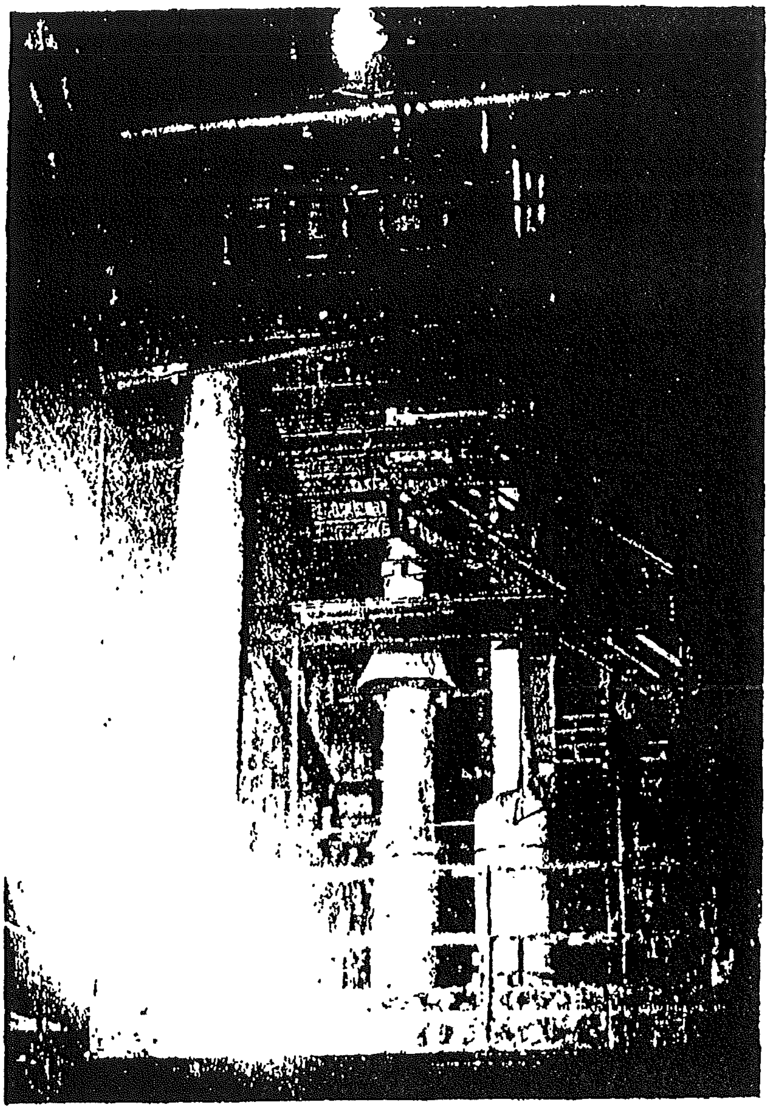
Top view showing #1 preheater center, #2 preheater left, and converter right.

Extreme right shows lead trap. Bent pipe out top of this trap discharges into bottom of fractionating column.

The one inch lines shown coming from the tops of each pot and manifolded into the horizontal 1½" line are release lines and are used for equalizing pot pressures when shutting down unit.

Note welded covers on #1 preheater and lead traps.

DSW 001341

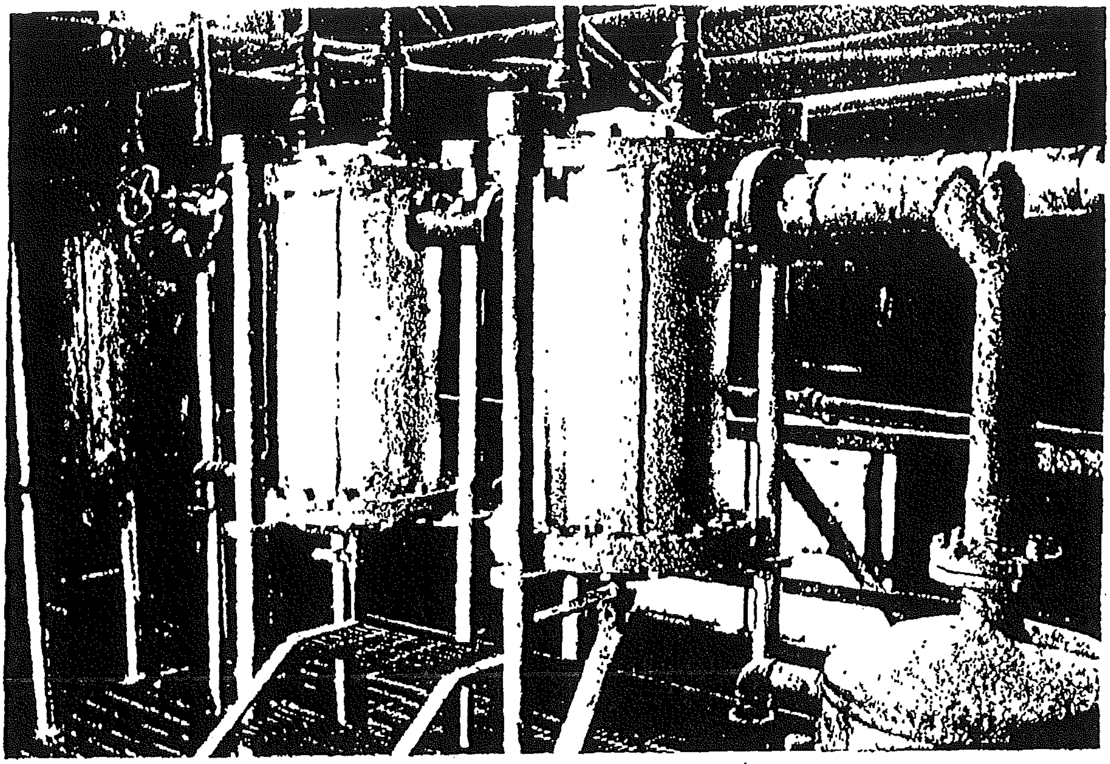


DIPHENYL UNIT

Fractionating column at left. Dephlegmator and condensers on upper platform.

DSW 001342

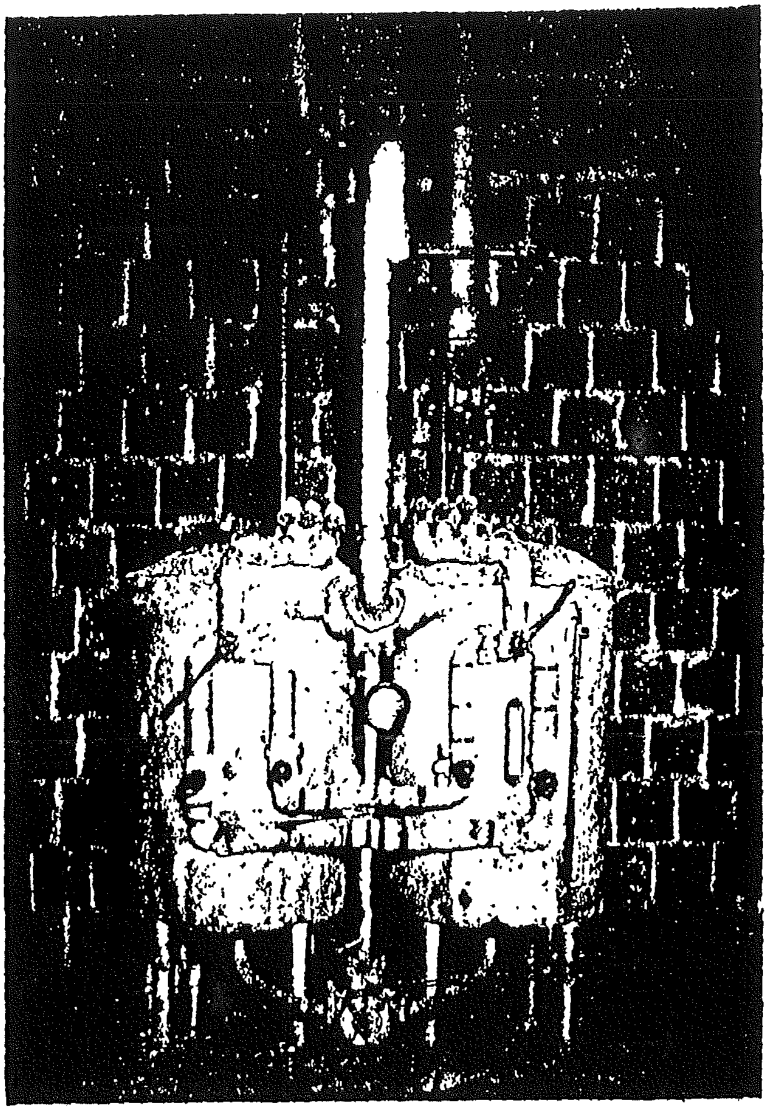
ADA 000695



DIPHENYL UNIT

Extreme right shows top of fractionating column. Right center shows dephlegmator. Condensed product returns to column. Left center and extreme left shows benzol condensers. Condensed product returned to feed tanks. Upper pipe connections are cooling water.

DSW 001343



ACTIVATED ALUMINA BENZOL ADSORBER

Chambers used alternately. Cooling water used during adsorption, steam used for re-activation.

DSW 001344

ADA 000697

Benzol - Diphenyl and High Boiler Separation
The separation of the Benzol, Diphenyl, High Boiler mixture collected in the sump tanks is done in three steps using three stills, viz:

Benzol Still
This still consists of a horizontal tank heated by a tubular steam chest using steam at 120 - 125# gage pressure. This tank is connected to a fractionating column equipped with a coil type dephlegmator and a tubular condenser.

The product collected in the sump tanks is pumped to this still every eight hours through a 1½" Gould centrifugal pump and the still boiled down once in each 24 hours. The benzol which is distilled out is returned to the diphenyl unit feed tanks and re-used. The residue remaining in the still consisting of 5 - 10% Benzol, Diphenyl and High Boiler is then dumped into the Diphenyl still.

Diphenyl Still
This still consists of a vertical tank, a fractionating column packed with 1¼" Bregeat Spirals and a jacketed pipe type condenser. The tank is equipped with a submerged type Rumsey centrifugal pump which circulates the diphenyl - high boiler mixture through a gas fired coil heater and back into the tank.

Wilson-Maulen Pyod thermocouples located in the tank, at the inlet and outlet of the heating coil and in the column head, connected to a Brown Recording Potentiometer serve as controls for this still.

The charge, which has the following approximate composition

Benzol	5%	B. P.	80°C
Low boiling hydrocarbons	1%	B. P.	100° - 150°C
Diphenyl	75%	B. P.	255°C
High Boiler, Tars and Carbon	18%	B. P.	375°C (approx.),

is run by gravity from the benzol still to the diphenyl still. Low heat is applied to the coil until the residual benzol has distilled. This is returned to the sump tanks. The heat is then increased and collection of the distillate in pans begun. These pans are made of galvanized iron and measure 25" x 47" x 5½". The first pan contains the low boiling hydrocarbons and is known as "heads". This amounts to approximately 50# per charge. When the potentiometer indicates that the boiling point of diphenyl has been reached, the delivery pipe is swung to another pan and heat and dephlegmator regulated in such manner as to distill technical diphenyl of 69.8°C or higher freezing point. The end point of the distillation is carried 20° - 30°C above the boiling point of diphenyl to insure as complete removal as possible. For this reason some High Boiler will be distilled over into the last pan. This is known as the "tails" and this material, along with the "heads", is reserved for the production of Aroclor 2565.

The residue from this distillation is known as "crude high boiler" and is either pumped to storage, drawn out in drums for storage or dumped into the High Boiler Still for subsequent distillation.

High Boiler Still

This is a vacuum still and is of the same general design as the diphenyl still except a receiver, trap and vacuum pump have been added.

The residue from the diphenyl distillation has the following approximate composition:

Diphenyl	1.0%
Orthodiphenylbenzene	8.0
Metadiphenylbenzene	10.0
Paradiphenylbenzene	56.0
Tetraphenyl, Tars and Carbon	25.0

Because of the high boiling range of this material (350°-460°) it is necessary to use vacuum distillation. The boiling range at 50 mm is reduced to 225° - 275°C.

The charge is run by gravity into the High Boiler Still. The temperature at which it is dumped is above its boiling point at the reduced pressure (50 mm). The circulating pump is therefore started and the charge allowed to cool to approximately 175°C before the vacuum pump is started. A differential of 20°C between the inlet and outlet of the heating coil indicates satisfactory circulation. When the temperature has dropped to 175°C the vacuum pump is started and the temperature of the charge drops rapidly to 150°C at which temperature the residual diphenyl distills.

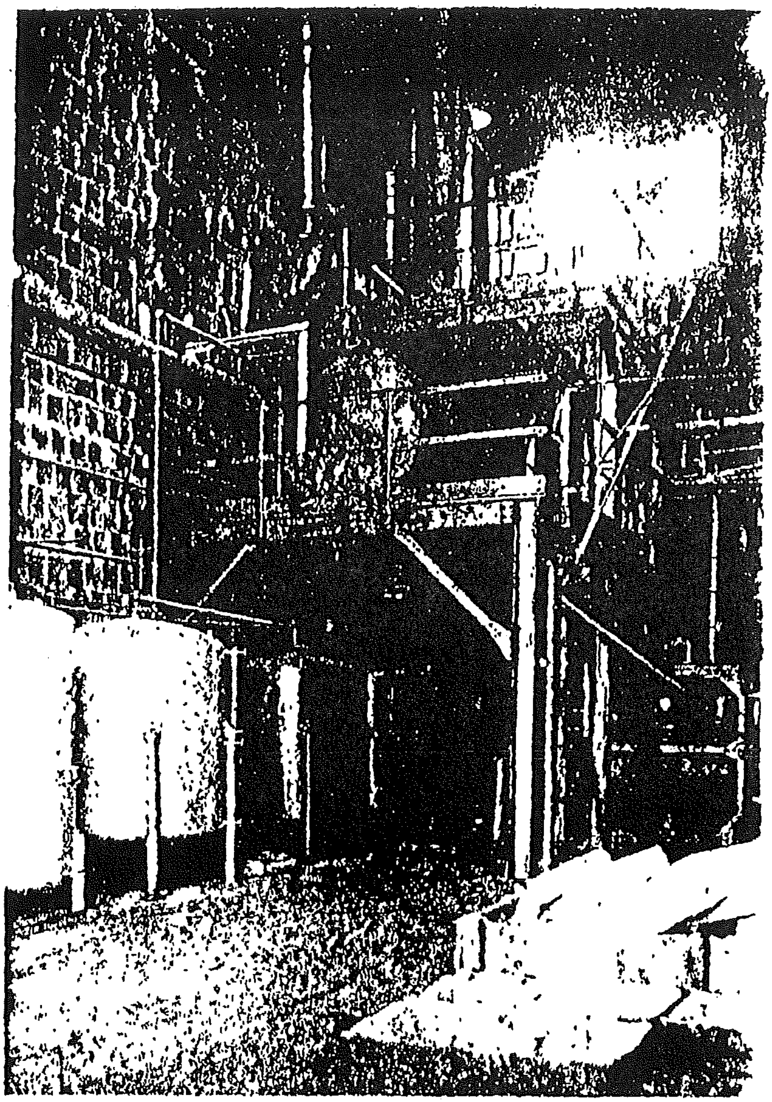
When the temperature of the column head indicates that all the diphenyl is distilled the vacuum is released and the residual diphenyl drawn from the receiver.

Distillation is then continued until approximately 80% of the original charge has distilled. This is determined by releasing the vacuum periodically and measuring the contents of the receiver. An experienced operator can judge this end point quite accurately by observing the flow of distillate through the sight glass.

The distillation is then stopped and the distilled high boiler drawn from the receiver into pans. The still residues consisting principally of tars and carbon is drawn out and discarded.

Capacity

The diphenyl unit has a capacity of 90,000# technical diphenyl per month.

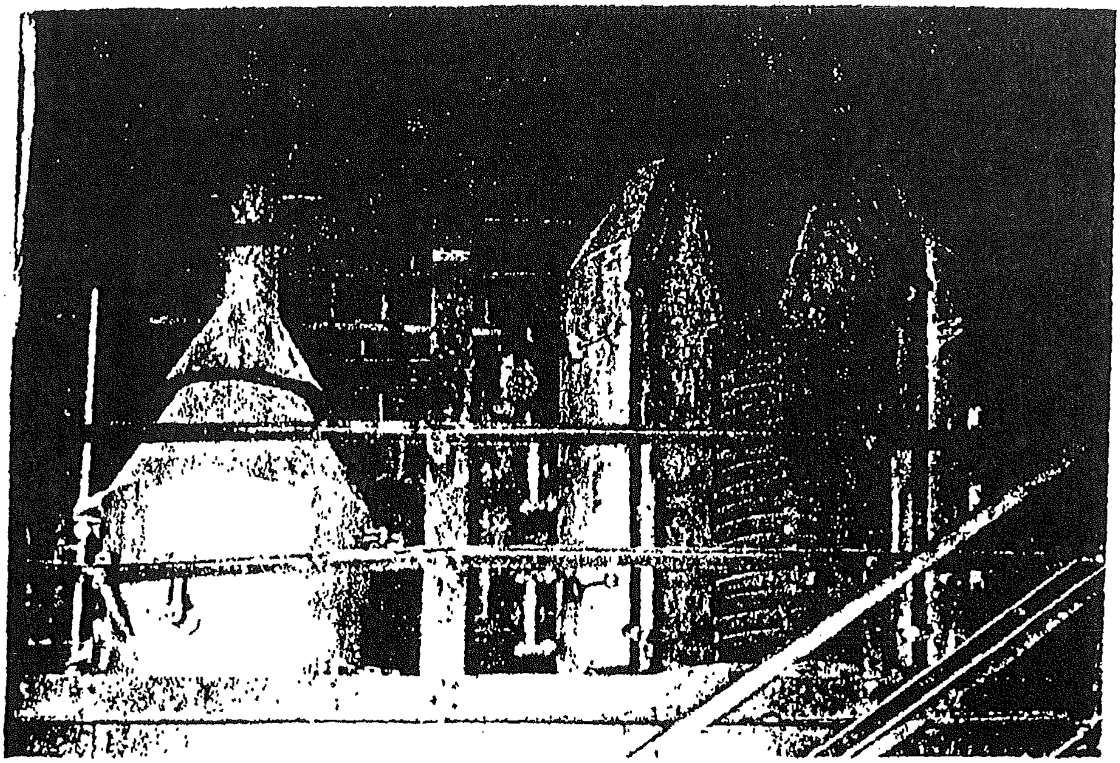


STILL ROOM

From left to right. Ground Floor. Benzol receiver from adsorber, three crude diphenyl sump tanks, underneath platform just discernable is diphenyl still tank, right, high boiler still tank. On platform, Benzol still with fractionating column and condenser on second platform. Foreground, diphenyl ready for packing.

DSW 001348

ADA 000701

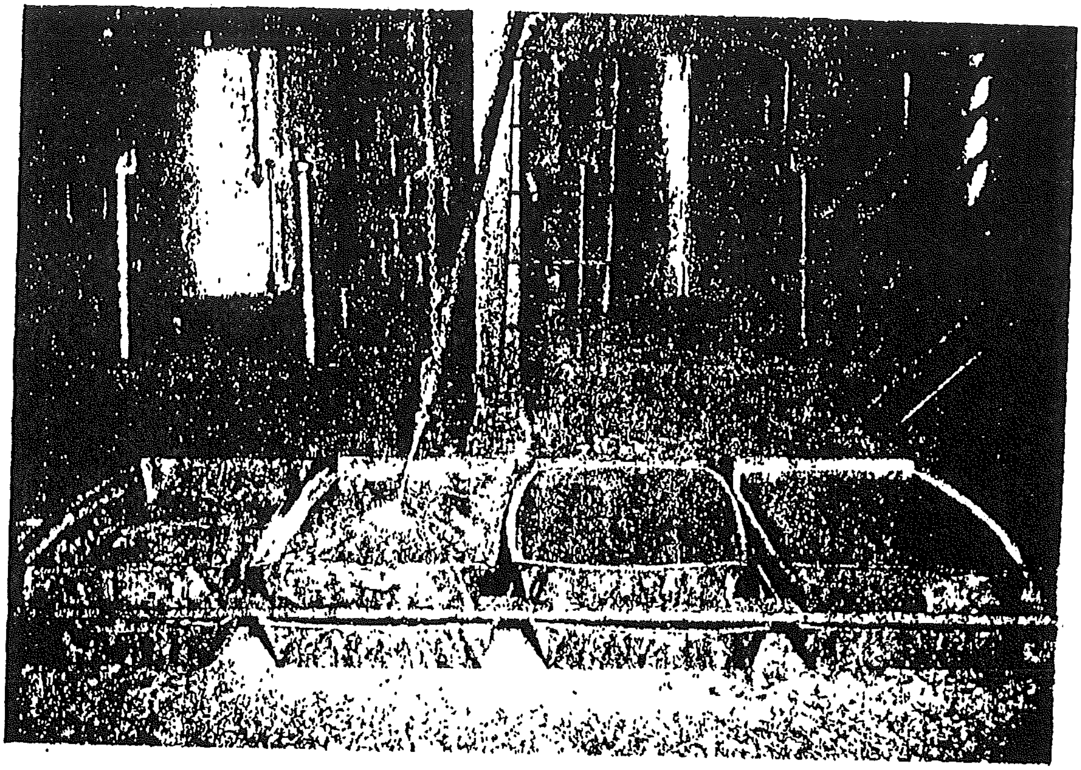


STILL HEATING COILS

Left, case closed, heating coil for high boiler still. Right, case open, heating coil for diphenyl still. These heating coils are mounted above the still tanks and are separated from them by a fire wall.

DSW 001349

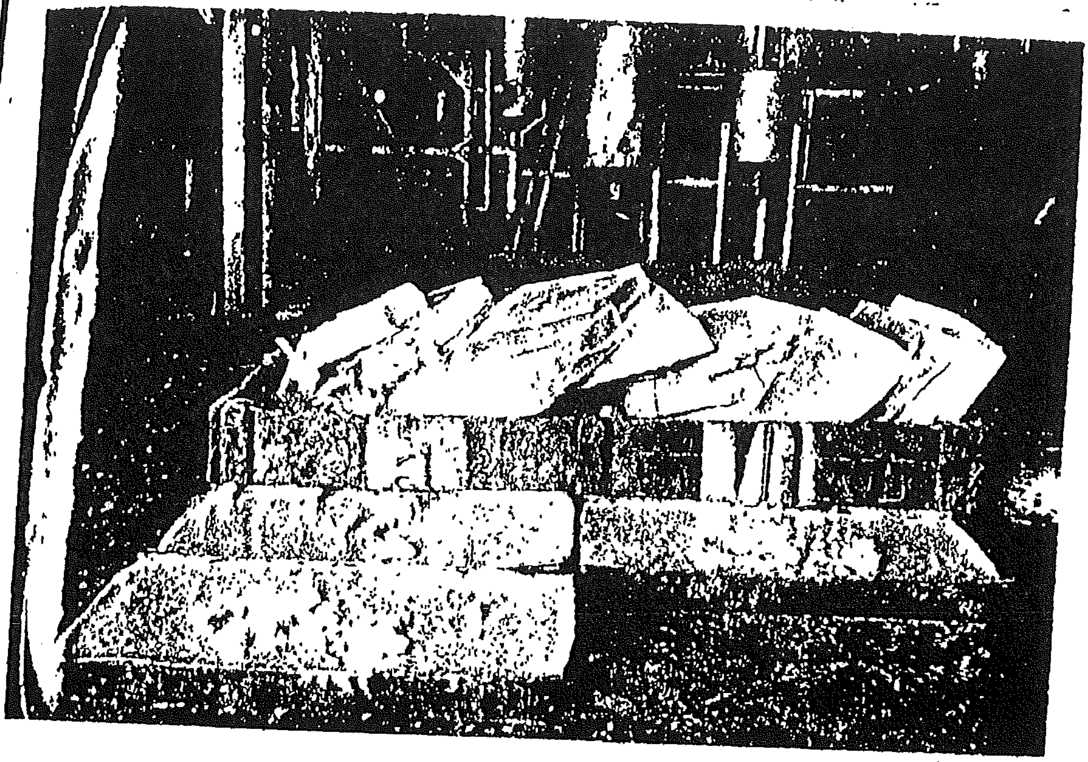
ADA 000702



DISTILLED DIPHENYL COLLECTION

DSW 001350

ADA 000703

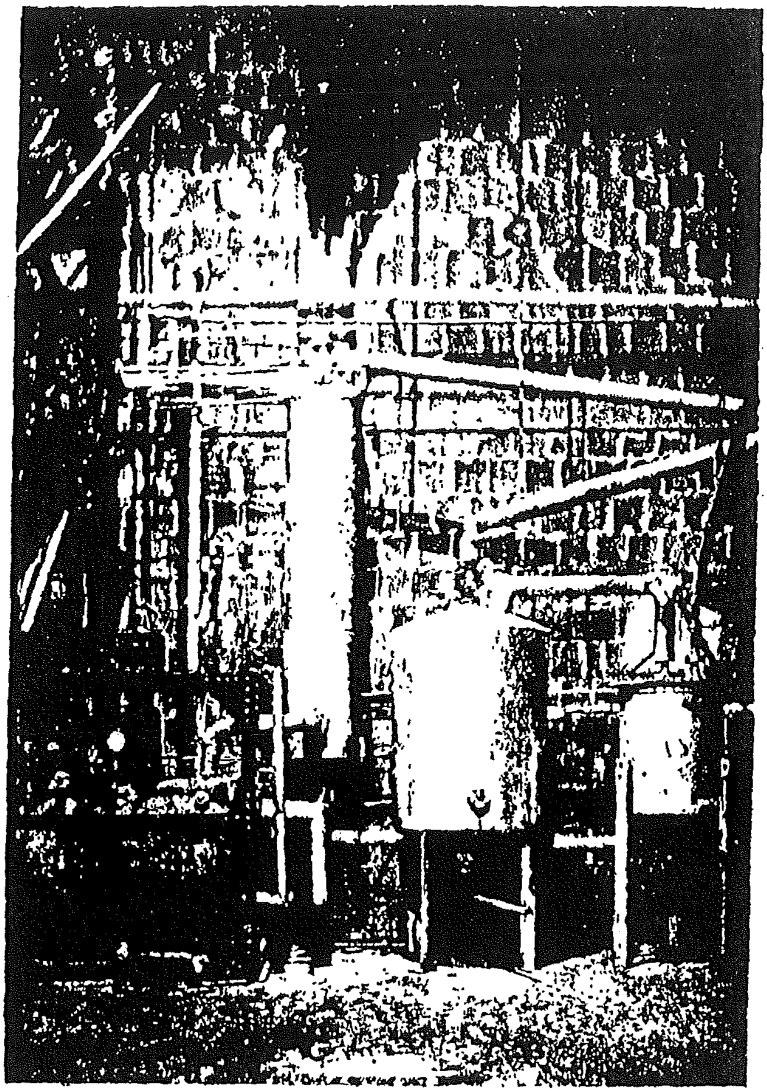


DIPHENYL READY FOR PACKING

Background shows high boiler still.

DSW 001351

ADA 000704



HIGH BOILER STILL

Left - Still tank showing drive to submerged type Rumsey pump. Left center, fractionating column. Right center, Receiver. Right, Trap.

DSW 001352

ADA 000705

CHEMICAL COMPANY, Diphenyl Operating Record

Ending 7:00 A. M. [illegible] 193[illegible] Unit No. [illegible]

No. 1 SHIFT

Moock FOREMAN Clegorn

Time	Cond'sr	Line	Feed	No. 1 Preh.	No. 2 Preh.	Conv.	Gallons per Hr.	Gallons in Sump	% Diphenyl	Approx. Pounds Diphenyl
		Pounds Pressure								
[illegible]	50	58	48	58	18	0	152	50	40	163
[illegible]	50.5	58	48	58	18	0	128	48	52	165
10	51	58	48	58	18	0	127	42	60	155
10.5	51	58	48	58	18	0	126	50	45	166
[illegible]	51	58	48	58	18	0	126	55	45	180
[illegible]	51	58	48	58	18	0	129	46	50	176
[illegible]	51	58	48	58	18	0	128	40	60	176
[illegible]	51	58	48	58	18	0	126	50	50	164

Start	Time Lost	Delays—Cause	Total
		B - 4 78" After 72.5	
			Converter Temperature 540°C

Fed to Benzol Still from No. 2 Sump Tank | 45-1/2 inches Benzol let down to No. 4 Supply Tank
" " " " " Catch I

No. 2 SHIFT

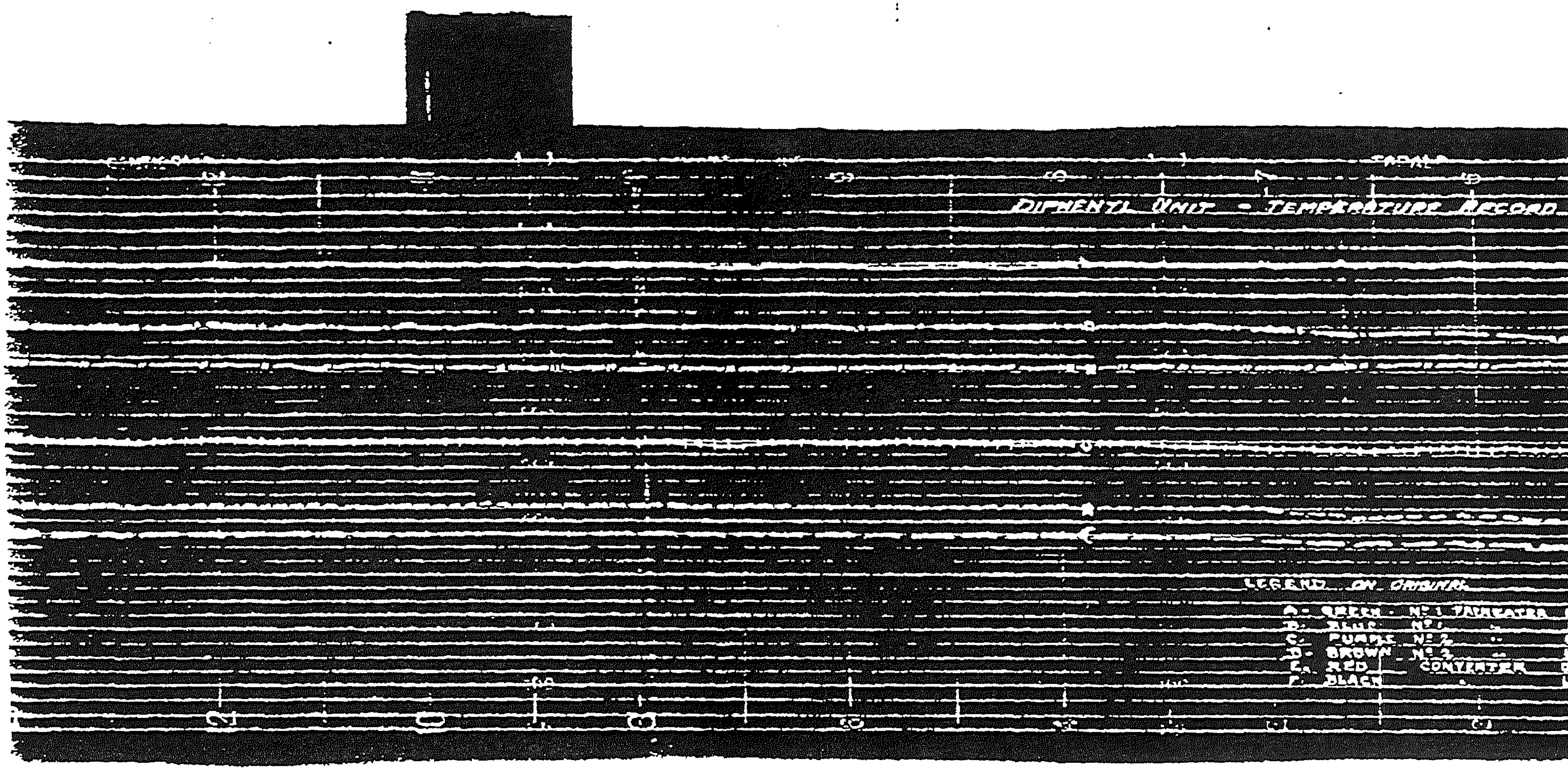
Beale FOREMAN

Time	Cond'sr	Line	Feed	No. 1 Preh.	No. 2 Preh.	Conv.	Gallons per Hr.	Gallons in Sump	% Diphenyl	Approx. Pounds Diphenyl
[illegible]	51	58	48	58	18	0	126	45	55	176
[illegible]	51	58	48	58	18	0	130	48	51	181
[illegible]	50.5	58	48	58	18	0	127	45	52	173
[illegible]	51	58	48	58	18	0	129	45	55	175
[illegible]	50.5	58	48	58	18	0	128	45	52	172
[illegible]	51	58	48	58	18	0	126	40	50	170
[illegible]	50	58	48	58	18	0	129	48	49	177
[illegible]	50	58	48	58	18	0	129	40	61	170

Start	Time Lost	Delays—Cause	Total

DSW 001353

ADA 000706



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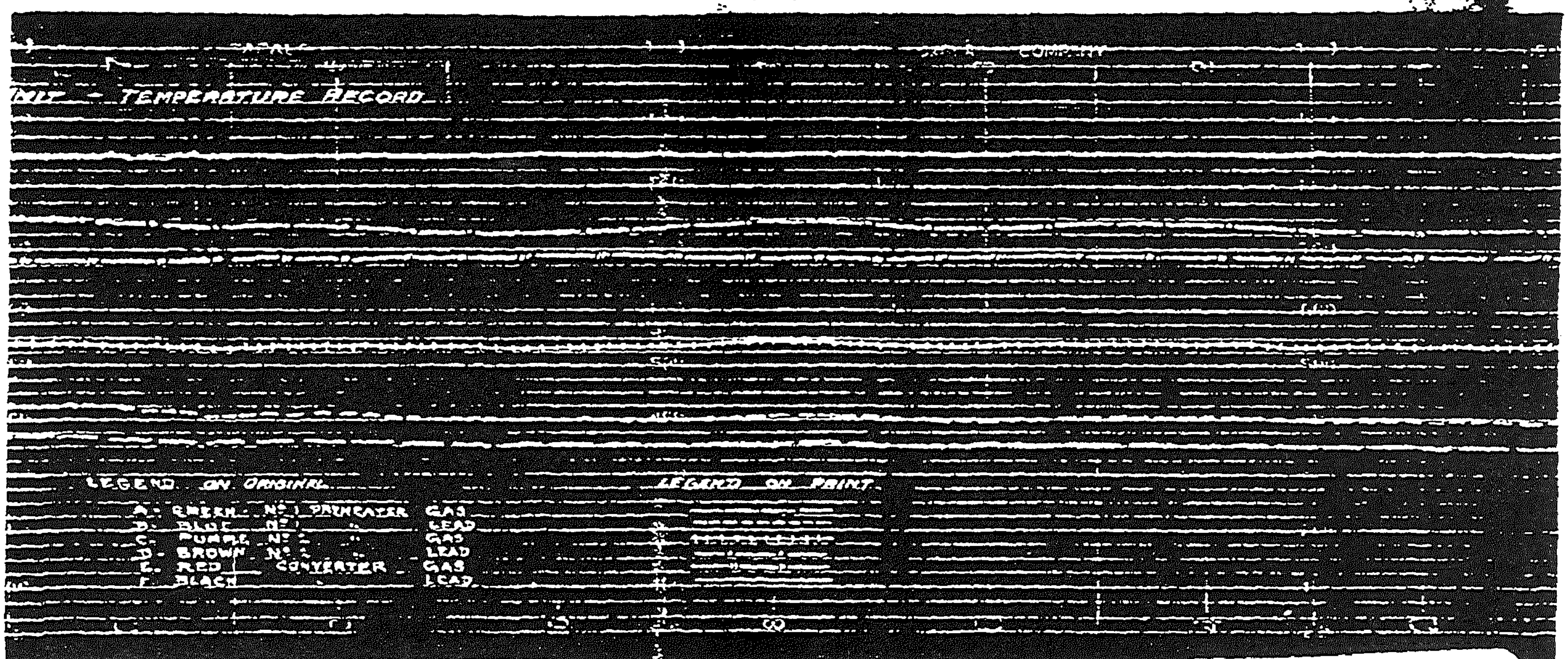

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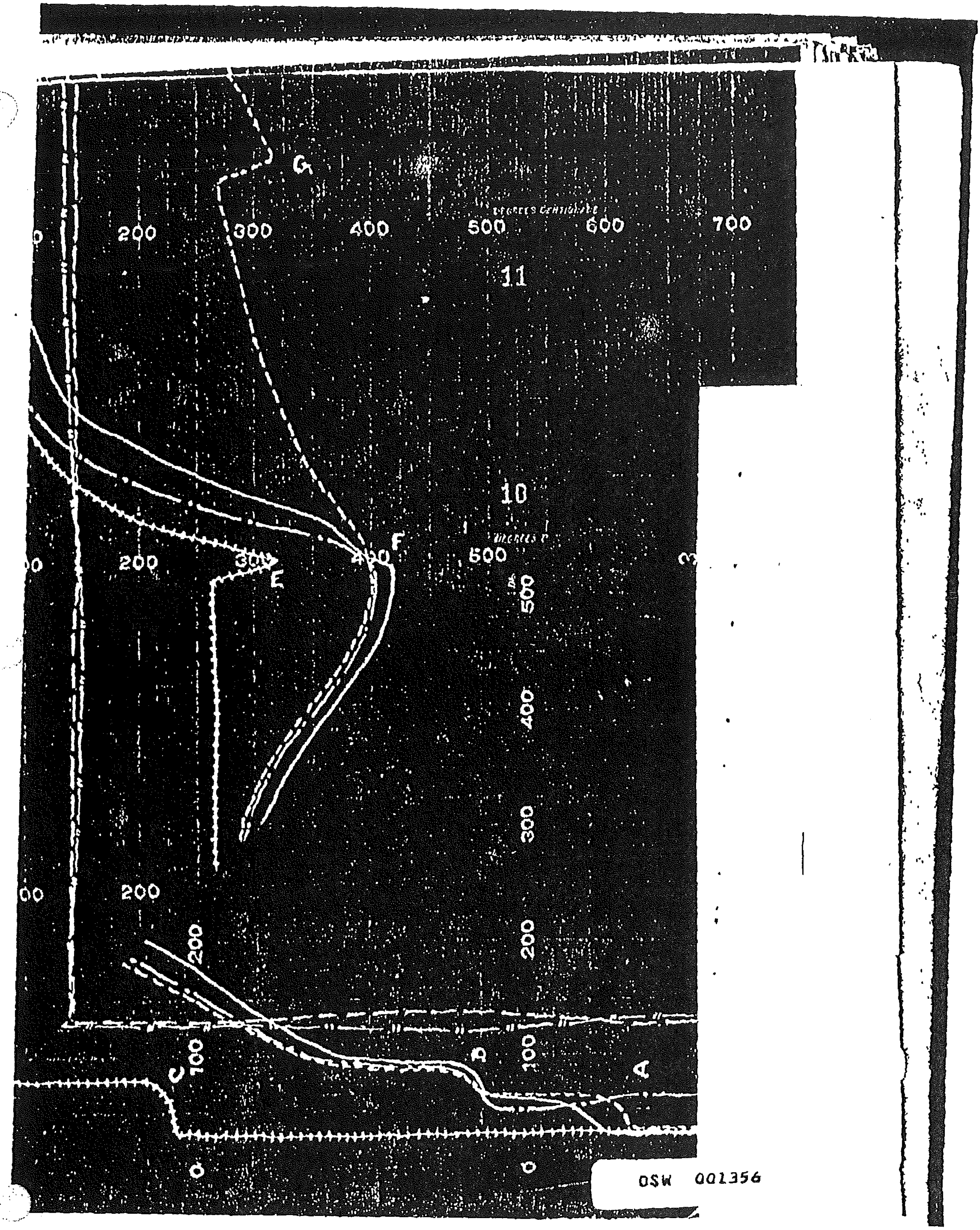

G
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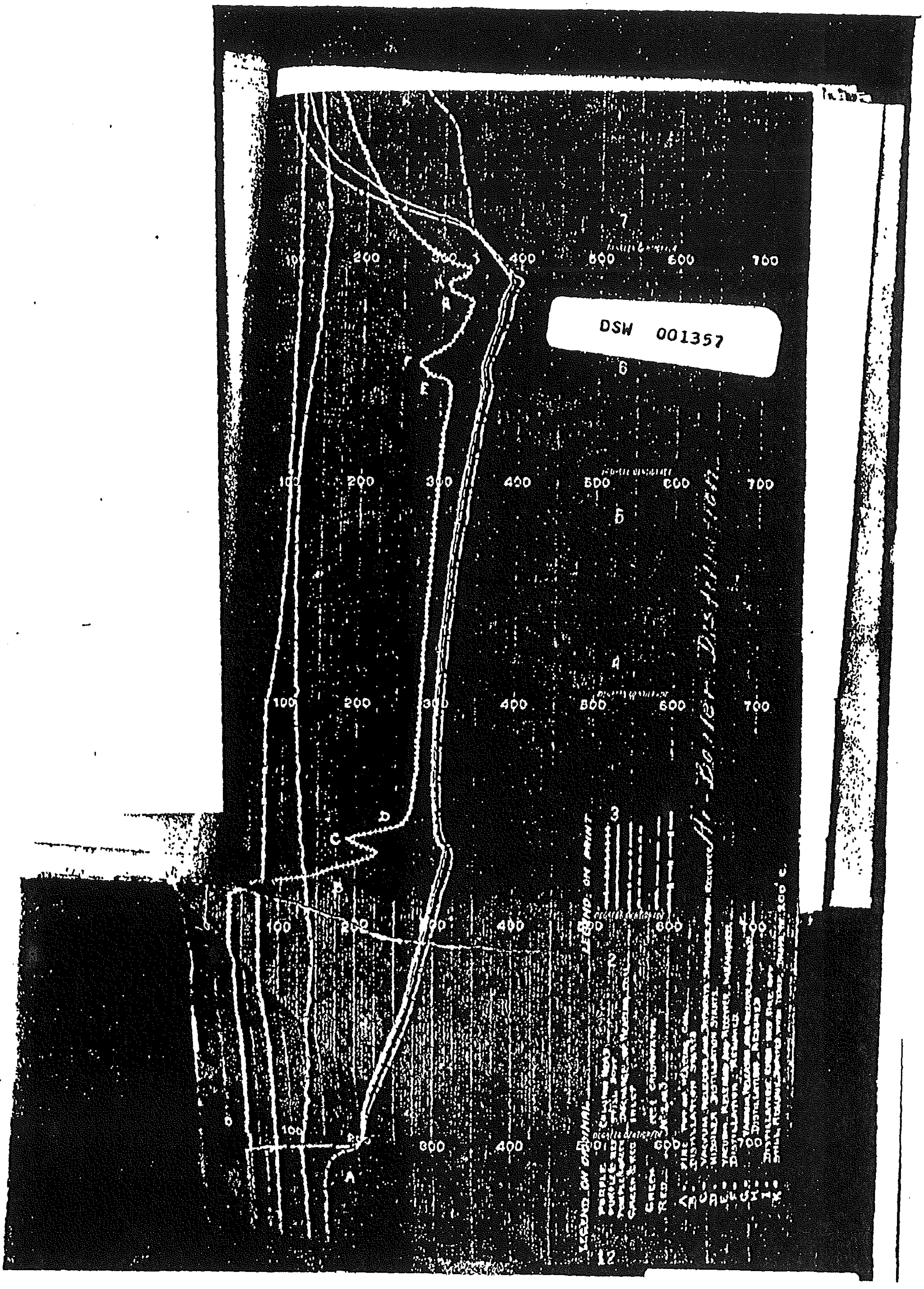

ADA 000710

DIPHENYL PLANT

DAILY REPORT FOR [illegible]

Production:

Technical Diphenyl		[illegible]	Pounds		
Crude High Boiler		[illegible]	"		
Total		[illegible]	"		
Distilled High Boiler		[illegible]	"		

Hydrochloric:

[illegible]		[illegible]	Inches		Lbs.
Aroclor [illegible]	Batch No.	[illegible]		[illegible]	Lbs.
Aroclor	Batch No.				Lbs.
Aroclor	Batch No.				Lbs.

Inventories:

Benzol

Storage Tank [illegible] 1/2 Inches.

Consumptions:

Gas	#1 Unit	#2 Unit	Diphenyl Still
Today	cu.ft.	[illegible] cu.ft.	[illegible] cu.ft.
Previous day	cu.ft.	[illegible] cu.ft.	[illegible] cu.ft.
Consumed	cu.ft.	[illegible] cu.ft.	[illegible] cu.ft.

Diphenyl	[illegible] Lbs.	For [illegible]
Crude High Boiler	[illegible] Lbs.	For [illegible]
Distilled High Boiler	Lbs.	For

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APPENDIX

NOTES ON THE OPERATION OF THE DIPHENYL UNIT

Instruments

Flow Meter	Schutte Koerting 1/2", #1825
Thermocouples	Wilson Maulen Pyods (iron - constantan)
Recording Pyrometer	Wilson Maulen 6 Point Tapalog
Recording Potentiometer	Brown 6 Point
Temperature Controls	Wilson Maulen Potentiometer actuating American Radiator Co. motor valves.
Gas Burners	Combustion Engineering Co. High Pressure (25#)
Tank Guage	Uehling Tank-O-Meter

Starting the Unit
After a careful check has been made of the various control equipment, feed lines, feed pump, release lines, water lines and other equipment the gas burners are lighted and the lead temperature in the pots brought up to operating temperature. This requires approximately six hours. During this period the stack containing the benzol vaporizer is closed and the products of combustion discharged through a separate stack. This is done to prevent overheating of the vaporizer coil.

When the system has reached operating temperature it is swept out thoroughly with carbon dioxide so as to remove any traces of air and avoid explosive mixtures of air and benzol. After this precaution the benzol feed pump is started and the flow of benzol started through the unit. The spent burner gases are then turned through the stack containing the benzol vaporizer and the waste heat utilized. The rate of benzol flow is then gradually raised and the whole system brought into equilibrium at a flow of approximately 150 gallons per hour.

Stopping the Unit
Shutting the unit down is a reversal of starting it. The products of combustion are cut off the vaporizer coil, the benzol flow is stopped and the feed pump shut down. The system is then swept out thoroughly for ten minutes with carbon dioxide to insure complete removal of benzol. The release lines at the tops of the pots are then opened to equalize the pot pressures, care being taken to open the converter release, the #2 preheater release, and the #1 preheater release in the order named to avoid blow back of lead. The

gas is then shut off and if the shut down is to be for any extended time, all water and steam is also shut off.

Operation of the Lectrodryer

This piece of equipment is a two chamber activated alumina adsorber used for removing benzol from the hydrogen produced in the manufacture of diphenyl and also for collecting the benzol vapors issuing from the vents of all feed and collection tanks.

The chambers are equipped with pipe coils connected through two way valves to steam and water. During the adsorbing period cooling water is turned through the coils while during the re-activation period steam is turned through the coils.

The operating periods are six hours, during which time adsorption is taking place in one chamber while re-activation is being accomplished in the other chamber.

The temperature of the adsorbing chamber is held below 55°C. The re-activation chamber is heated as hot as possible with 125# steam for five hours, then cooled to below 55°C during the sixth hour.

Operating Difficulties

The present diphenyl unit is operated with a time efficiency of 97% plus. The principal factor causing lost operating time is carbon formation.

This is indicated by changes in operating pressures and occurs most frequently in the following order:

1. Goosenecks from converter to trap and from trap to column, must be cleaned bi-monthly and requires about four hours. Spare goosenecks are carried and exchanged.

2. Converter distributor pipe. Must be cleaned or changed semi-annually. Spare distributor carried on hand. Changing requires about eight hours.

3. No. 2 preheater. Must be cleaned about once a year.

The carbon formed is very hard and dense and it is necessary to either chip it out or burn out with oxygen.

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Other factors occasionally causing lost operating time are:

Distributor failure due to pipe breakage and indicated by change in operating pressures or reduced conversion.

Thermocouple well failure due to vibration and indicated by leakage around the connection at the top of the pot.

Feed pump failure due to wear in the pump to such an extent that it fails to deliver the necessary pressure.

Pot failure indicated by lead running out the firebox door. Whenever a pot is opened it is essential that the lead be measured and any necessary make up added. The mechanical action of the vaporized benzol passing through the molten lead causes passage of this metal from one pot to another and from the converter pot to the lead trap. The proper depth of lead in No. 1 and No. 2 preheaters is 48" and in the converter 42".

The sump tanks and feed tanks are vented through the Lectrodryer. Occasionally these lines become plugged causing back pressure on the tanks or backing up of the distilled benzol. It is necessary to clean these vent lines whenever this occurs.

Benzol used for Diphenyl manufacture is bought under the following specifications;

Grade Commercially Pure Benzol.

Color The visible color shall not be darker than a solution of .0030 gm. of potassium bichromate in one liter of water. Comparison is to be made in Nessler Tubes - 50 cc size.

Distillation The product shall distill from start to dry within 2°C. within which degrees shall be included the true boiling point of Pure Benzene (80.2°C.) The method of distillation shall be in accordance with method E-4, Journ. Ind. Eng. Chem. 10,1006 (1918).

Acid Wash The wash shall not be darker than No. 4 Barrett Colorimetric Scale. Test in accordance with directions for Test E-6, Journ. Ind. Eng. Chem.

Acidity Finished product shall contain no free acid.

Specific Gravity Specific Gravity at 15.5°C shall be between .875 and .886.

Moisture Must be essentially free of H_2O.

Freezing Point Freezing point must be not below 4.8°C. Test in accordance with method of U. S. Steel Corp.

DSW 001362

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MANUFACTURE OF AROCLORS

Aroclor is a name used to designate the chlorinated products of diphenyl. The physical properties vary from a light mobile oil to crystalline and non-crystalline solids depending upon the degree of chlorination and the composition of the raw material. Straight diphenyl chlorinated yields a liquid product of increasing viscosity up to and including 65% chlorine. Above this the yield is a crystalline solid. Straight high boiler and mixtures of diphenyl and high boiler chlorinated yield products of increasing viscosity up to non-crystalline resins.

A numerical system of nomenclature consisting of four digits has been developed for identifying the various Aroclors.

The first digit denotes the raw material used for the chlorination. The figure "one" indicates 100% technical diphenyl. The second digit denotes whether or not the product is distilled. The figure "one" indicating undistilled, the figure "two" indicating distilled. The last two digits denote the approximate percentage of chlorine contained in the finished product. There are several arbitrary deviations from the above nomenclature as follows:

1. Aroclors 4065 and 4465. The former is the crude from which the latter is obtained by distillation. The starting raw material contains 40% distilled high boiler and 60% technical diphenyl. This is chlorinated to 65% chlorine.

2. Aroclors 5060 and 5460. The former is the crude from which the latter is distilled. The starting raw material is 100% distilled high boiler. This is chlorinated to 60%.

3. Aroclor 2565. This is an undistilled product. The starting raw material consists of 25% crude high boiler and 75% technical diphenyl. This is chlorinated to 65% chlorine.

The Aroclors are not pure compounds but are mixtures of two or more compounds. However, from their chlorine content they may be assumed to have the following composition:

Aroclors 1142	and 1242	=	$C_{12}H_7Cl_3$
1148	1248		$C_{12}H_6Cl_4$
1154	1254		$C_{12}H_5Cl_5$
1160	1260		$C_{12}H_4Cl_6 + C_{12}H_3Cl_7$
1162	1262		$C_{12}H_3Cl_7$
1168	1268		$C_{12}H_2Cl_8 + C_{12}HCl_9$
1169	1269		$C_{12}HCl_9$
4065	4465		$C_{12}H_2Cl_8 + C_{18}H_4Cl_{11}$
5060	5460		$C_{18}H_5Cl_{10}$

The manufacture of Aroclors is divided into two operations, viz:

The chlorination of the raw materials to crude Aroclors.

The distillation of the crude Aroclors to finished products.

<u>Chlorination</u>
This operation is shown diagramatically by drawing No. C-6852, by actual photographs and is described as follows:

<u>Raw Materials</u>
The raw materials used in the manufacture of the Aroclors are principally Technical Diphenyl and Chlorine. Some few of the Aroclors require crude high boiler or distilled high boiler as will be shown later.

<u>Raw Materials Handling</u>
Diphenyl or high boiler is taken from storage, weighed and dumped into steam heated melting tanks.

Liquid chlorine is received in single unit tank cars which are leased from the manufacturer. No additional storage is provided but chlorine is used directly from the tank cars after being passed through a vaporiser. The vaporiser consists of a cylindrical tank containing water, heated by steam, in which is immersed two 10" x 48" cylinders. The liquid chlorine is brought in from the tank car through a 1" line and manifolded so as to feed both cylinders. Vaporisation of the liquid takes place and the gaseous chlorine is discharged from the cylinders through 1/2" expansion valves into 1" lines so manifolded that any chlorinator may be fed from either vaporiser. Pressure guages are used to measure the chlorine flow.

DSW 001364

Chlorinators

The chlorinators are three cylindrical steel tanks, 16 ft. high by 5 ft. diameter. These have flanged convex covers and bottoms. They are filled to half their depth with iron turnings for catalysis. These are enclosed in an iron shell 27" in diameter.

A one inch coil for steam and water extends around the length of catalyst chamber between the two shells. The spacing between each turn is approximately two inches.

A two inch line leads from the bottom of each chlorinator through a Gould centrifugal pump to the top of the chlorinator. This is for circulation of the charge during chlorination. In the covers of the chlorinators are inlet lines for charging hydrochloric acid discharge lines, circulating lines and vent lines for use while charging. The hydrochloric acid lines from No. 2 and No. 3 chlorinators enter a common line leading to the hydrochloric acid absorption system. No. 1 chlorinator, which is used for 1168 and 1169 discharges its acid through a trap and thence into the common acid line beyond No. 3 chlorinator.

Operation

The required charge is weighed and dumped into the melting pot, melted and pumped to the chlorinator. The chlorine flow is kept low at first to prevent local overheating and diphenyl sublimation. The circulating pump is started after turning on the chlorine. As the density of the charge increases, the chlorine flow is increased until the pressure reaches the maximum shown in the table. The heat of reaction of chlorine and diphenyl is so great that cooling water is necessary to keep the temperature within the required limits. The maximum temperature shown in the table is that necessary to insure complete reaction and to keep the charge molten.

During chlorination some material is carried out of the chlorinator with the Hcl gas by entrainment, foaming or sublimation. For this reason, No. 2 and No. 3 chlorinators are never used simultaneously, one being used as a trap while the other is in operation. Number one chlorinator being used for crystalline Aroclors has its own trapping system since contamination of any of the other Aroclors with crystals would render them unsaleable. A separate trapping system for each chlorinator would increase the capacity by one third. The average amount of trappings is 2% of the finished batch. When sufficient has accumulated, it is used for the manufacture of 1168 or 1169, or for any of the Aroclors if no trappings from the last two are present.

In chlorinating Aroclor containing high boiler particular care must be taken to minimize foaming. The surface tension of this material is apparently higher than that of diphenyl, therefore a higher chlorinating temperature will reduce foaming tendency. Chlorine must not be fed too rapidly at low temperature.

Samples are taken from time to time to determine progress of the chlorination and near the end extreme care must be taken to prevent overrunning the end point. However, an experienced operator can finish to specifications with great accuracy.

When chlorination is complete Aroclors 1142, 1154, 1160, 1162, 4065 and 2565 are pumped to the blowing tank. This tank is equipped with steam coils and perforated pipe for compressed air. Residual hydrochloric acid is blown out here. The blowing period varies from four to twelve hours, depending on the Aroclor. Those that are to be shipped as crude are given the maximum period while those to be distilled are given the minimum. When specified by the customer that any of the liquid crude Aroclors be shipped as such, they are given special treatment with Fuller's Earth and hydrated lime and then filtered. After blowing, the material is drawn directly into shipping containers or into 50 gallon drum for storage preparatory to distillation.

Aroclors 1168 and 1169 melt too high to be blown so are drawn directly from the chlorinator into open top drums. These crudes must be discharged from the chlorinator as rapidly as possible in order to prevent freezing. This method of discharging is disagreeable as well as hazardous to the operators and could be greatly improved by the installation of flaking equipment.

The following table and chart shows the operating factors involved in the production of each Aroclor.

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Aroclor No.	Lbs. Charged Per Batch	Chlorination Period (Hours)	Chlorine Pressure (Lbs.) Start	Chlorine Pressure (Lbs.) End	Chlorinator Temperature °C Start	Chlorinator Temperature °C End	Pounds Produced Per Batch	Batch Finished To	Per Chlorinator Per Month (Lbs.)
1242	3,600# Diphenyl	18 - 20	7	17	120	135	5,500	Specific Gravity 1.383 - 1.388 @ 65°C (4)	209,000
1248	3,600# "	20 - 22	7	17	120	135	6,000	Specific Gravity 1.412 - 1.417 @ 65°C (4)	204,000
1254	3,600# "	27 - 30	7	20	120	150	7,000	Specific Gravity 1.502 - 1.507 @ 65°C (4)	175,000
1260	3,600# "	30 - 32	7	20	120	150	7,500	Specific Gravity 1.559 - 1.564 @ 90°C (4)	172,500
1262	3,600# "	30 - 32	7	20	120	150	7,500	Specific Gravity 1.565 - 1.570 @ 100°C (4)	172,500
1268	3,000# "	35 - 40	6	25	120	190	8,000	Hold Point 125° - 150°C (5)	152,000
1270	2,800# "	40 - 44	6	30	120	285	8,000	Hold Point 280 - 285°C (5)	158,000
2565	2,250# " 750# C.H.B.(1)	35 - 40	6	25	120	175	7,500	Softening Point Barrett 78° - 80°C (6)	142,500
4465	1,500# Diphenyl 1,500# D.H.B.(2)	35 - 40	6	25	120	175	7,500	Softening Point Barrett 78° - 80°C (6)	142,500
5460	3,000# D.H.B.(2)	40 - 42	6	25	120	250	7,500	Softening Point Barrett 120° - 125°C (6)	111,250

(1) Crude High Boiler
(2) Distilled High Boiler
(3) The average monthly capacity of three chlorinators would be 480,000 lbs.
(4) These densities are taken by the operators with hydrometers of suitable range. The final samples are checked by the control laboratory with the Westphal Balance.
(5) The "Hold Point" is that point in the freezing range where the material shows the characteristic increase in temperature due to heat of crystallization.
(6) The softening point is determined in the plant by the Barrett Ring method, the material being finished by comparison with a standard of known softening point.

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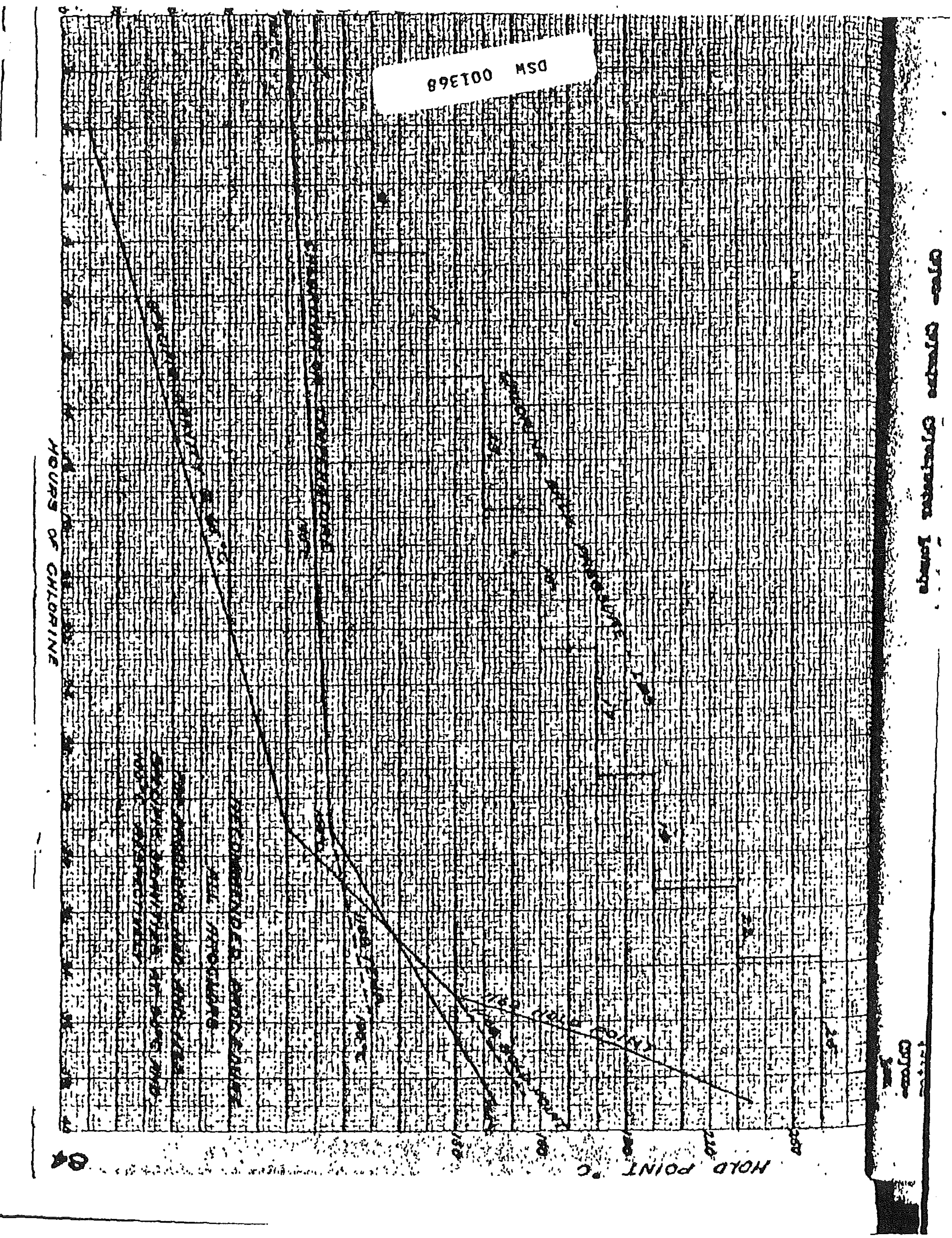
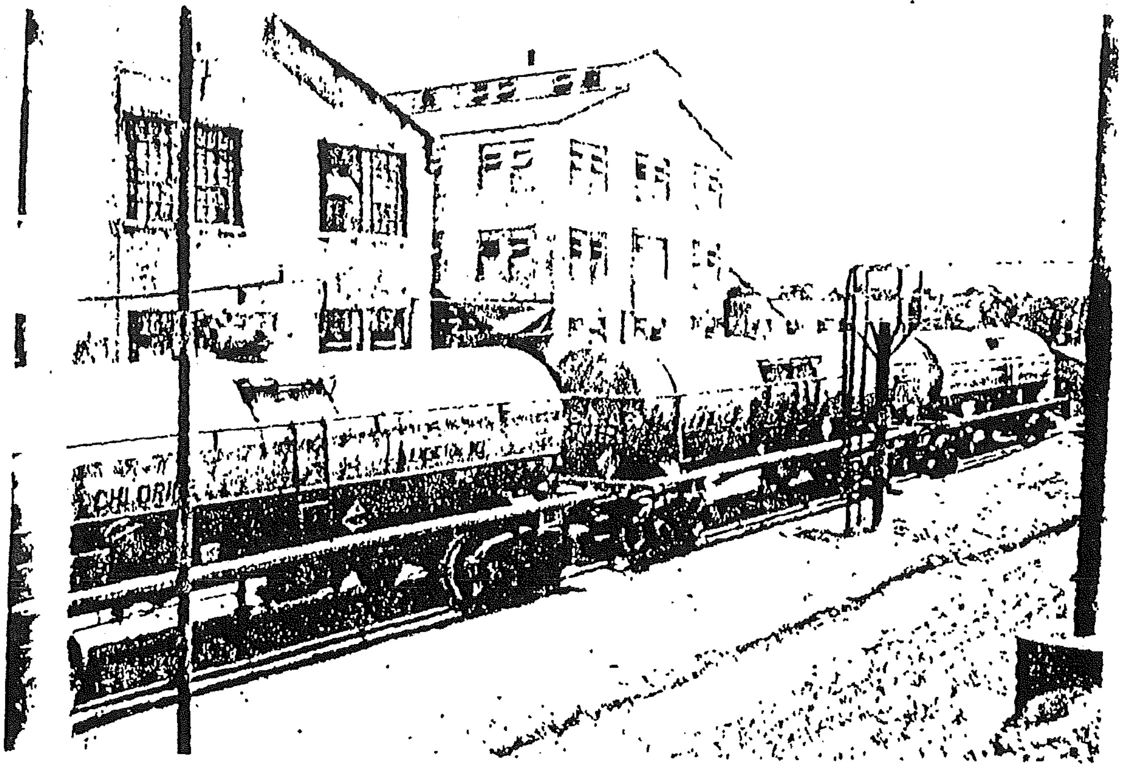
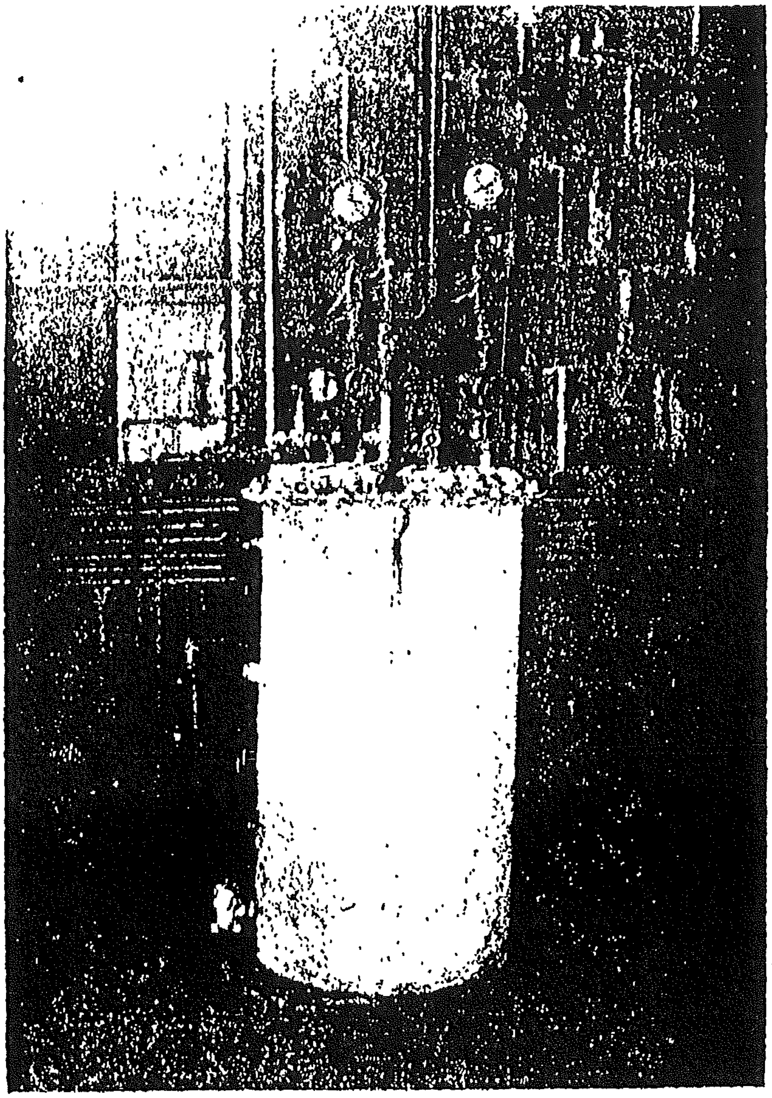




CHLORINE STORAGE

Two end cars are at liquid chlorine discharging stations. Center car is at hydrochloric acid loading station.

DSW 001369

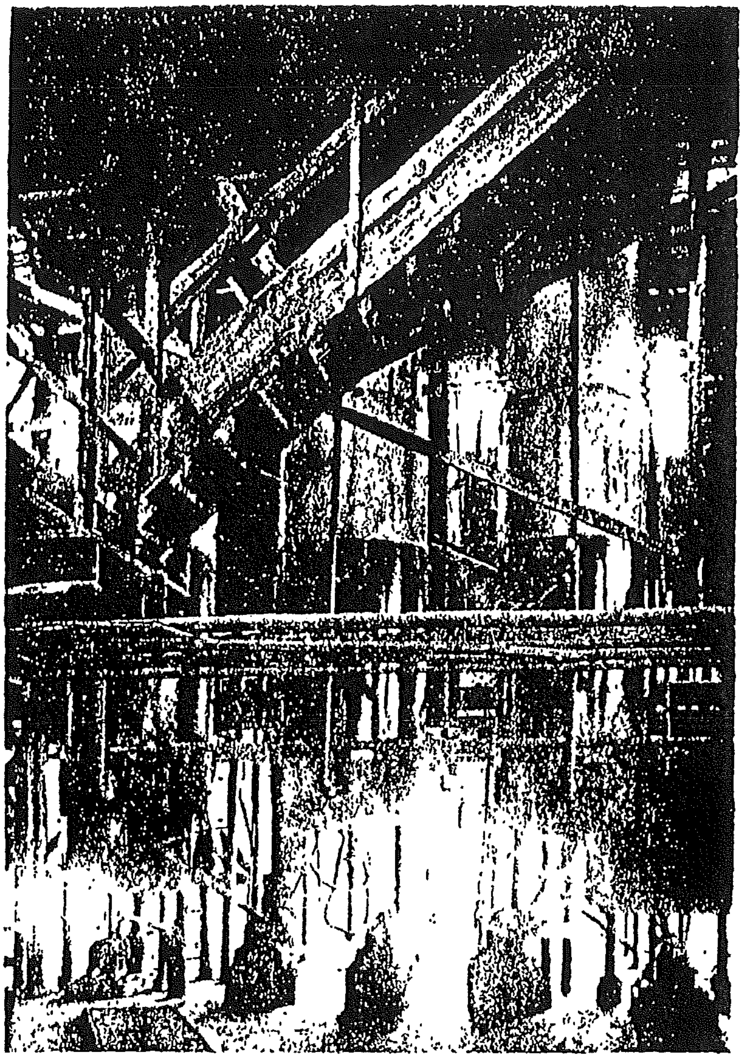


CHLORINE VAPORIZER

Note: Hot water tank containing two vaporizing cylinders. Liquid chlorine fed in through dirt trap at left. Gaseous chlorine discharged thru expansion valves at top. Upper pressure guages used for controling chlorine flow.

DSW 001370

ADA 000723

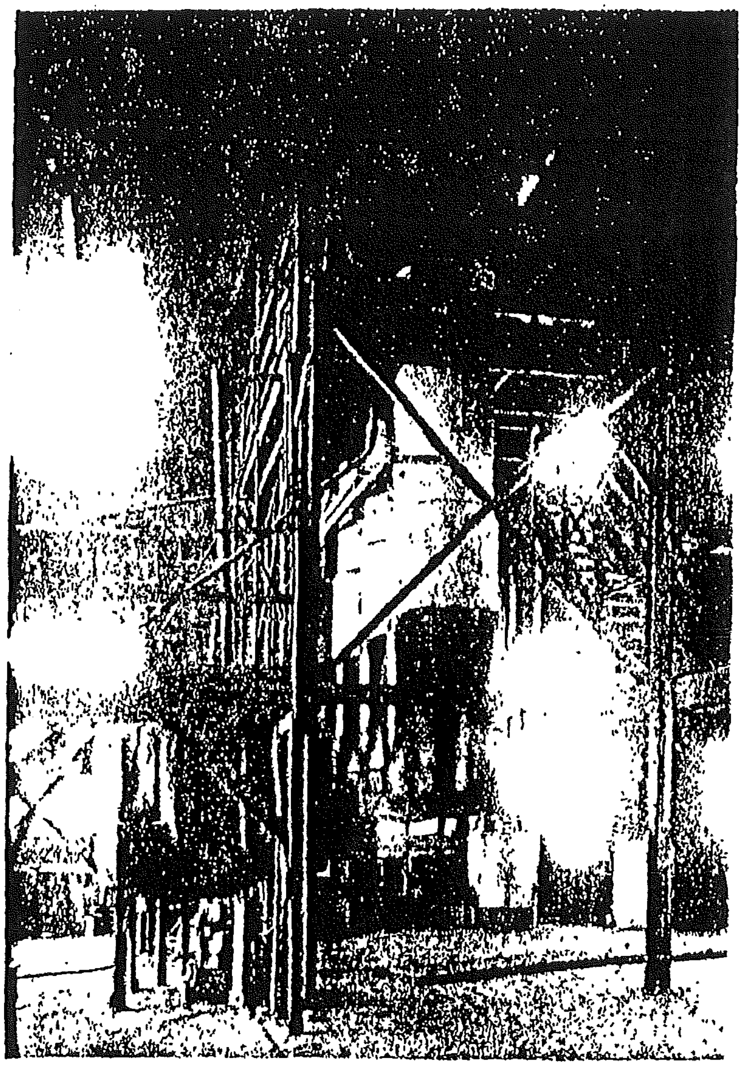


CHLORINATORS

The three chlorinators and their circulating pumps are shown. The vertical lines entering the chlorinators near the bottom are chlorine lines. The bolted plates permit distributor replacement. In the background can be seen the bottoms of the two diphenyl melting tanks and the pumps used for charging the chlorinators.

DSW 001371

ADA 000724



CHLORINATORS

Left - Charge melting tank, Center - Chlorinators. Extreme right - Chlorine vaporizer.

DSW 001372

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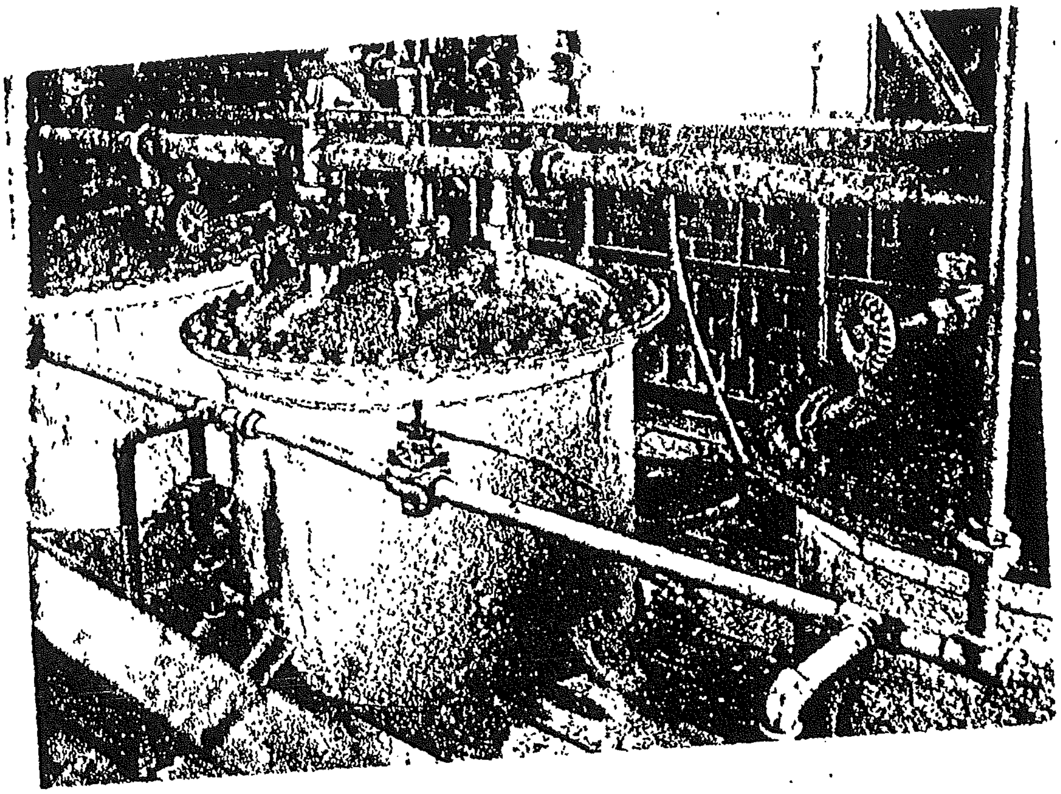

TOP VIEW OF CHLORINATORS

Shows charging line, hydrochloric acid gas discharge line, and circulating line. Foreground shows chlorine manifold. Chlorine pipe shown entering chlorinator near top, extends to bottom of chlorinator but is only used in case of distributor trouble.

DSW 001373

ADA 000726

DISCHARGING CHLORINATOR

The "solid" Aroclors such as 1168 and 1169 are discharged into open top drums. This is a very disagreeable, as well as dangerous, operation. Flakers could be used. "Liquid" Aroclors are pumped.

DSW 001374

ADA 000727

CHLORINATION RECORD

...lor No. 1154 Batch No. [illegible] Chlorinator No. [illegible]

...rted by Kircus Time 8:55 AM PM Date 8-11-55

...ished by Corn Time 12:10 AM PM Date 8-12-55

...tal Hours 28 Hours Weight of Batch 7,285

5800# Diphenyl

Time	Vapor Temp.	Back Press.	End Point Batch	End Point Std.	Time	Vap. Temp.	Back Press.	End Point Batch	End Point Std.
:55	84	7	Cl. on		9:00	80	10		
	84	7				80	10		
:00	85	7			10:00	80	10	1,476 @ 10:10	
	84	7				85	10		
:00	85	7			11:00	85	10		
	85	7				85	10	1,494 @ 11:18	
:00	80	7			12:00	85		1,501 @ 11:41	
	80	7							
1:00	80	7			1:00				
	80	7					Finish	1,503	
2:00	80	9	Circulating		2:00				
	80	9				@ 12:10			
3:00	80	9			3:00				
	80	9					Air	Steam On	
4:00	80	9	1,155 @ 4:00		4:00				
	85	9				B.P.	@ 1:00		
5:00	85	9			5:00				
	80	9							
6:00	80	11	1,175 @ 6:00		6:00				

DSW 001375

ADA 000728

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Hydrochloric Acid Recovery

Since one mol of hydrochloric acid is produced for every mol of chlorine used, provision must be made for the collection of this by-product. The acid gas passes from the chlorinators downward through a trap, thence out of the building through a two inch pipe to a second trap at the absorption system. From this trap it passes through a cooling tower to Vitreosil absorbers. These are thirteen in number placed one above the other. Water enters the uppermost absorber and flows countercurrent to the gas, sufficient water being added to produce 18°Be. acid. The condensed acid passes through a series of one inch Pyrex cooling tubes, thence to a 20,000 gallon rubber lined steel storage tank. Any unabsorbed gas passes from the absorbers to a drowning tower, the weak acid absorbed here being run over limestone to the sewer. Approximately 88% of the acid produced is recovered and absorbed when storage capacity is available. However, this is limited to the storage tank mentioned above and two 8,000 gallon tank cars, so much of the acid made is wasted. Should Sales warrant such, the recovery could be substantially increased by pumping the weak acid from the drowning tower to the absorbers.

Operating Difficulties

On the whole the chlorination process gives practically no trouble. A few items of maintenance are listed below in the order of the frequency of their occurrence.

1. Distributors: The perforated plate of these must be replaced semi-annually as it corrodes through in a six to eight months period.
2. The Merco-Nordstrom Valves on the chlorine lines must be replaced once or twice a year due to leaky stems.
3. The Crane valves on the vaporizer are equipped with regrindable seats which must be reground semi-annually.

DSW 001376

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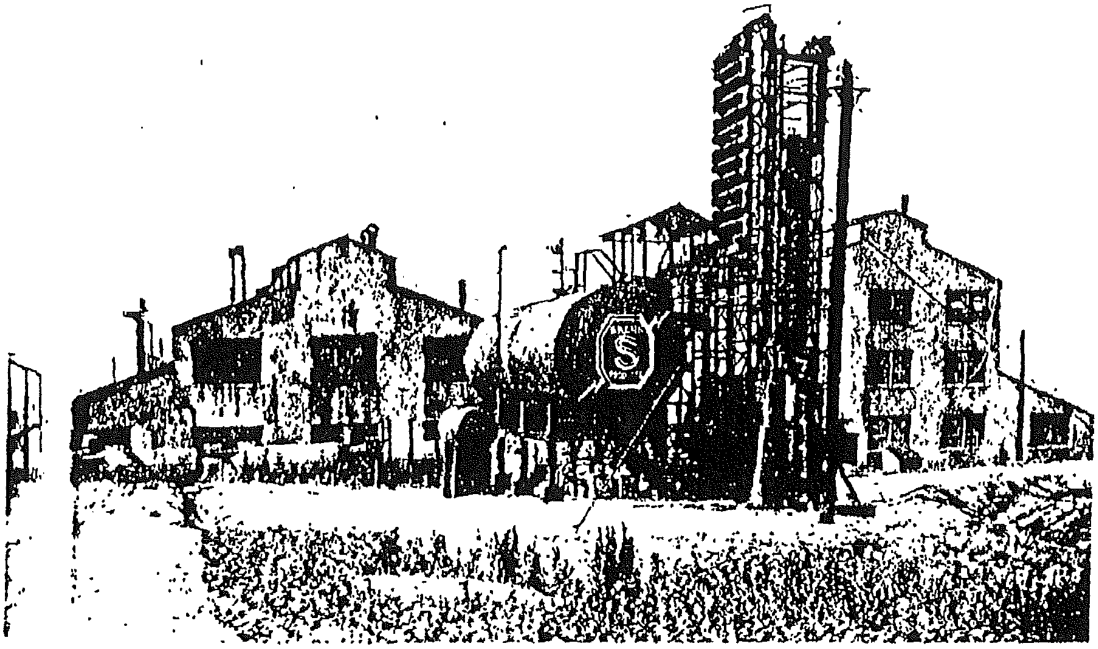

HYDROCHLORIC ACID PLANT

Shows Vitreosil absorbers, coke packed drowning tower. 20,000 gallon rubber lined acid storage tank. Small tank at left is for 20°Be. acid carboy shipments. Note also gravity rubber-lined line for tank car loading.

DSW 001377

HYDROCHLORIC ACID RECOVERY

Shift #1: Foreman [illegible] Operator [illegible] Date 5-8-55

	Absorbers				Drowning Tower		
	Temp. oC	Sp. Gr. As Is	o Be. As Is	Correct o Be.	Temp. o C	Sp. Gr. As Is	
	[illegible]		16.2	18.00			
					Composite Sample		
	[illegible]		16.0	18.21		18.41 Be.	
	[illegible]		14.8	18.61			
	[illegible]		15.0	17.45			
	[illegible]		17.2	18.81			
	[illegible]		16.7	19.15			
	[illegible]		16.0	18.05			
	[illegible]		14.7	17.01			
	[illegible]		14.8	17.00	Composite Sample		
						18.17 Be.	
	[illegible]		14.8	17.65			

Shift #2: Foreman [illegible] Operator [illegible] Date 5-8-55

	[illegible]		14.8	17.00			
	[illegible]		15.4	18.00	Composite 18.18		
	[illegible]		15.8	18.15			
	[illegible]		16.1	18.17			
	[illegible]		16.2	18.87			
	[illegible]		16.1	18.11			
	[illegible]		16.8	18.60			
	[illegible]		17.	18.77			
	[illegible]		17.1	18.81			
	[illegible]		17.	18.80			
	[illegible]		16.7	18.71			
	[illegible]		17.	18.85			
	[illegible]		16.8	18.75			
	[illegible]		16.4	18.41			
	[illegible]		16.4	18.45			
	[illegible]		16.4	18.84	Composite 18.[illegible]		

DSW 001378

ADA 000731

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Distillation of the Crude Aroclors

All of the Aroclors except Aroclor 2565 are distilled to finished products. Two different type stills are used, viz:

1. Atmospheric, non-fractionating, used for production of Aroclor 1268.

2. Vacuum, Circulating, Coil Heated Type, used for production of all other Aroclors.

Aroclor 1268 Distillation

The distillation of this product has resolved itself into a very simple operation after having passed through a rather complicated development period during which several types of distillation were tried. Aroclor 1268 is the most highly chlorinated diphenyl having the approximate formula $C_{12}HCl_9$. It melts at approximately 265°C and has a distillation range, at atmospheric pressure, of 400° – 450°C.

Attempts to vacuum distill this product failed due to the great tendency of the material to sublime. The fact that its boiling point under 1 – 5 mm pressure very closely approaches its melting point renders the design of a satisfactory vacuum still extremely difficult.

Distillation at atmospheric pressure using a closed retort equipped with an agitator and discharging the vapor through a packed column were unsatisfactory because of low yields and the difficulty of removing the still bottoms.

Attempts were made to sublime the product by passing a current of air over the surface of the boiling liquid and collecting the sublimed product in a dust collector. This method gave fairly satisfactory results but was discarded due to expense of installation and cost of operation.

Another problem which presented itself in the production of this material was its physical condition after distillation. Collection in pans with the resulting slow cooling gave large hard crystals which the customer found impossible to grind to the desired fineness of one half micron.

Air sublimation and also distilling into a water quenching tank with subsequent drying of the quenched product gave a product of satisfactory physical characteristics. The latter was discarded however in favor of the flaking wheel which is used at present.

The distillation as is now carried on is shown by parts of drawing #C-6889, by an actual photograph and is described as follows:

Equipment - The equipment used in this operation consists of four steel pots 56" in diameter x 48" deep, which are used alternately in two suitable fire brick, steel jacketed settings. Inside the pots is welded a steel ring or gutter approximately 18" from the bottom. This ring serves as a collector for the distilled product which is condensed on the sides of the upper part of the pot. The distillate is discharged through a short pipe set in the side of the pot at the ring level. The pots are also provided with suitable covers held in place by C clamps.

Heating is accomplished by gas fired through a four ring, low pressure, multi-jet burner manufactured by The Surface Combustion Company.

The distillate is collected in a pan which feeds a 24" diameter x 16" water cooled flaking wheel rotating at 11 RPM. The flaker is enclosed by a hood which is connected to a Raymond dust collector equipped with stainless steel cyclones.

Temperature is measured by Pyod thermocouples connected to a Wilson-Maulen Indicating Pyrometer.

A Sirocco exhaust fan is used to clear the still room of fumes liberated at the end of a distillation.

DSW 001380

ADA 000733

WATER_PCB-SD0000045900

Operation

Five hundred pounds of Aroclor 1169 and twenty five pounds of hydrated lime are weighed out and charged into the distillation pot. A gasket of asbestos rope is placed around the flange and the cover put on with C clamps. This cover is a flat steel plate with a six inch pipe 12" high welded in its center. The pot is now lifted into the setting with a chain-hoist and the hood connected to the exhaust fan swung into position over the pipe in the cover. The delivery pipe is lengthened to reach the flaker reservoir by a sleeve and nipple. A thermocouple is placed in the material through the cover and heat is applied. While heating the material to distillation temperature the flame is allowed to cover the bottom of the pot. When distillation starts, the flame is reduced so that it lacks two inches of touching the bottom. If this is not done the charge will boil over into the collecting ring and give black material on the flaker. The sides of the pot above the collecting ring act as a condenser for the distillate. When the temperature of the material reaches 400°C distillation is imminent. The first of the distillate is generally black so this is collected in a small pan inserted through a door in the hood. This is withdrawn when the stream clears up. The material caught here is re-distilled with a subsequent batch. The flaker and dust collector are both started the moment distillation starts. The average time for heating to distillation point is one hour and distillation also consumes one hour. The distilling range of this Aroclor is 400° - 460°C.

Toward the end of distillation the color of the distillate again darkens due to decomposition. The operator must watch for this and separate the dark material from the shippable product. This material is also re-distilled. Completion of distillation is marked by what is known as the "blow". This is a rather violent ebullition of dark colored sublimate which is strongly acid. Its probable cause is sudden decomposition of very high boiling chlorinated residue which releases considerable hydrochloric acid in a short space of time causing sublimation. When this occurs the fire is immediately cut and the exhaust fan started. The blow lasts about five minutes. When it ceases the pot is lifted from the setting, placed in a water filled pan on a cart, rolled into the yard and allowed to cool.

DSW 001381

ADA 000734

WATER_PCB-SD0000045901

The still residues are a mixture of carbon, partially decomposed Aroclor, hydrochloric acid and calcium chloride. This mixture clings rather tenaciously to the bottom of the pot. Its removal is accomplished only by inverting the pot and hammering vigorously with sledges. This is somewhat damaging to the pot bottoms. An improved type of pot which may eliminate this pounding is now being built.

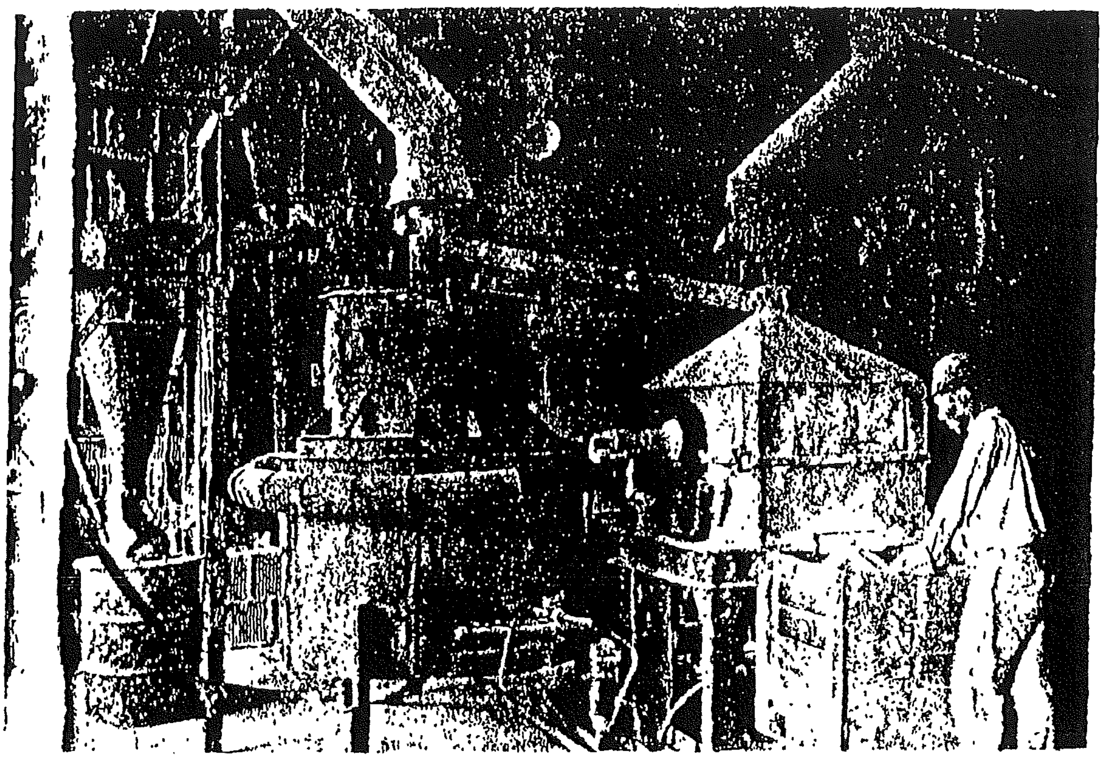
Each twenty four hour production of flaked Aroclor and the dust caught in the collector is mixed as thoroughly as possible in order to obtain a uniform color and packed either in 200 lb. lined burlap bags or 400 lb. slack barrels, as the customer desires. The greatest portion, however, is shipped in bags.

<u>Capacity</u>
The above described 1289 stills have a combined capacity of 6,000# per 24 hour day or 180,000# per month.

<u>Operating Difficulties</u>
1. The flaker now in use was not designed for this service and has too low capacity. In spite of great care the pan over flows occasionally. This must be collected and re-distilled.

2. Unless the delivery pipe from the stills is kept hot during the heating period it stops up when distillation starts. This necessitates cleaning it with a rod.

3. If for any reason a charge is brought to boiling and then allowed to cool without distilling, it will decompose when reheated and the recovery will be low.



AROCLOR 1268 DISTILLATION

Left shows cyclone dust collectors. Center, distillation pot in gas fired setting. Right, Flaking roll showing discharge of product. Just behind the flaking roll can be seen a second still. These two are operated alternately. Large pipes above stills lead to an exhaust fan.

DSW 001383

ADA 000736

PRODUCTION RECORD - AROCLOR 1269

STILL NO. 5	DATE 6-17-55
BATCH NO. 105-4	OPERATOR Turner
POUNDS 1169 CHARGED	SHIFT NO. 1 FROM 7:00 A.M. P.M.
NEW MATERIAL C-500 - 25 L. A.	
PRERUN OR OFF-COLOR	TO 5:00 A.M. P.M.
POUNDS STILL BOTTOMS 70	
POUNDS PRERUN OR OFF-COLOR 5	
FIRE ON 7:15 A.M. P.M.	
DIST. STARTED 8:15 A.M. P.M.	
DIST. ENDED 2:00 A.M. P.M.	

POUNDS WET MATERIAL AFTER CENTRIFUGING Not Used

POUNDS Flaked 440

REMARKS:

Dust 15 Lbs.

DSW 001384

ADA 000737

Vacuum Distillation

All of the distilled Aroclors except 1269 are produced in a vacuum still.

This operation is shown by drawing C-6858, by a photograph and is described as follows:

Equipment - The equipment used for this operation consists of a heating tank, used for melting or warming the still charge, which discharges into the main still kettle. This still has a capacity of approximately 175 gallons. The charge of Aroclor is circulated from the bottom through a No. 5 Quimby pump to a gas fired heating coil and back into the top of the kettle. The vapor is discharged through a monel metal foam trap to a monel metal single tube condenser. The condensed product discharges through a sight glass into a monel metal lined receiver.

The entire system is evacuated to 1 - 5 mm through 80% caustic soda scrubbers by a Wheeler Three Stage Tubejet Vacuum Pump. A Devine Mechanical Vacuum Pump is provided as stand-by equipment. When needed to prevent freezing of the charge undergoing distillation Aroclor 1148 heated by gas is circulated through the following jacketed parts of the still set up.

- Line from still tank to Quimby pump
- Line from heating coil to still tank
- Charging line
- Quimby pump
- Quimby pump packing gland

The distilled Aroclor is transferred from the receiver to either of two 375 gallon galvanized blending tanks where several batches are mixed with Fuller's earth before passing through a 12" plate and frame Sperry filter press to finished storage.

Temperatures are measured by Pyods connected to a six point Wilson Maulen Tapalog. Two points each are measured at the inlet and outlet of the heating coil, one in the foam trap and one in the receiver.

DSW 001385

Operation

For the sake of brevity, Aroclors 1242, 1248, 1254, 1260 and 1262 and their crude homologues will be referred to hereafter as "liquid Aroclors", while Aroclors 1268, 4465 and 5460 and their crude homologues will be referred to as "solid Aroclors". The former are

ADA 000738

not all strictly liquids, but they are easily melted and, therefore, may be so classified. The liquid crude Aroclors are delivered to the Badger Still in bunged drums and the solids in open-head drums. For charging, the bunged drums are drawn up by a chain-hoist to a platform and the bung placed over the lip of the charging tank. Bung and vent are removed and the drum heated with a gas flame. Heating is not necessary for 1142 and 1148 in warm weather, but all must be heated in winter. The solid Aroclors are broken out of the drums into a box and shovelled into the charging pot. A temperature of 100° - 150° is sufficient for charging the liquids but the solids must be heated to 150° - 225°C to become sufficiently liquid to prevent freezing while charging. This operation is very crude and affords considerable room for improvement. A hot-oil system for heating the charging tank would be much more efficient and cleaner than the open gas flame now used.

One percent of hydrated lime is added to the crude Aroclors in the charging tank. This neutralizes any residual acid and prevents sublimation of ferric chloride which would discolor the distillate.

When the still is cold before charging, all jackets are warmed with hot Aroclor from the circulating system. If a solid Aroclor is to be distilled, a small charge of 1142 or 1148 is first circulated in the still at atmospheric pressure to heat the system thoroughly. This is pumped out just before the charge to be distilled is ready.

In dropping a charge a 40 mesh screen is placed over the funnel of the charging line to take out most of the lime and any foreign matter that may be in the crude. It is extremely important that no foreign matter get past this screen since the clearance between the screw and the barrel of the Quimby pump is extremely small and it is therefore easily stalled.

Just before charging, the Quimby pump is started and a low flame applied to the coils. When the charge is circulating, as indicated by a low temperature differential (10° - 20°C) between the inlet and outlet of the coil, circulation of hot Aroclor to all jackets but those around the Quimby pump packing glands is stopped and the jackets drained. The gas is now turned on full and the system evacuated. Distillation from a cold system starts in three to five hours after charging depending on the Aroclor being distilled. The lag between batches is 30 to 45 minutes.

DSW 001386

Since the crude charged per batch is 1,000 lbs. and the recovery 97%, only 30 lbs. of still residue will be left from each batch. This is not sufficient to maintain circulation, which requires at least 100 lbs. Therefore, the first three or four batches are not run to completion so that circulation may be maintained while residue is accumulating. Since the capacity of the receiver is only 1,200 lbs. these first batches must be split, the receiver emptied and distillation resumed without recharging. Subsequent batches are blended with the early ones so that the composition of the whole will be uniform.

During distillation the temperature of the foam trap coincides very closely with that of the inlet to the coil until near the end when the temperature of both the inlet and outlet increase rather rapidly while the foam trap temperature remains nearly constant. When a spread of 30° - 40° between the foam trap and inlet is attained distillation is complete. The above is true of the liquid Aroclors, and Aroclors 1268 and 5460. Aroclor 4465 consists of mixture of diphenyl and distilled high boiler chlorinated to 65% and has two distinct boiling ranges. The chlorinated diphenyl distills first and will coincide with the inlet as above. After this has distilled the inlet and outlet temperatures will increase and draw away from that of the foam trap and the stream of distillate will fall off. As the temperature of the liquid increases that of the vapor in the foam trap will increase until it again approaches that of the inlet. Another spread indicates the end of the distillation.

When distillation is complete the valve on the vacuum line is closed and the system vented at a point beyond the receiver. A measured crude charge of 17" in the charging tank is now dropped and circulated until the receiver is emptied to the blending tanks by means of compressed air applied through a valve in the vacuum line over the receiver. Distillation is now resumed.

From time to time excess still residue must be withdrawn from the kettle. This is done by partially opening a plug valve on the discharge side of the Quimby at the completion of a run. By using care in this operation circulation will be maintained through the coils while draining. However, if the valve is opened too wide the material in the coils will carbonize which necessitates drawing all residues and renewing the coil.

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When the still is to be taken out of operation the pump is shut down for a few minutes, a valve at the inlet to the coils closed and a vent plug in the coils opened so that any material remaining in the coils will be pulled through by vacuum. The still residues are now pumped out and a small charge of liquid Aroclor dropped and circulated for an hour. The latter is done so that the pump will run freely when next used. Otherwise the high melting still residues will freeze in the pump and cause it to stick.

For distillation of the liquid Aroclors the condenser must be cooled with water to effect complete condensation. Water is used intermittently here as needed. This need is indicated by "flashing" in the sight glass, which is a spraying and broken stream from the discharge lip. When solid Aroclors are being distilled the condenser is lagged and steam is used in the jacket. However, even these will flash during the early stages of distillation and some cooling is necessary. This is accomplished by mixing water with steam.

As mentioned above, all Aroclors but 1268 are blown to blending tanks to insure uniformity. The liquid Aroclors are treated with .02% of dried Fuller's earth, heated to 100°-125°C and filtered through the Sperry press into thirty or fifty gallon galvanized drums which are used as shipping containers. Aroclors 4465 and 5460 are blended but not treated with Fuller's earth since they melt too high to be filtered in the press. These are drawn out through diaper cloth into galvanized iron containers. Since the same blending tanks are used for both liquid and solid they must be carefully cleaned of Fuller's earth before using for 4465 and 5460 and then before using again for the liquids must be cleaned again. Aroclor 1268 is drawn directly from the receiver into galvanized iron pans. After this solidifies it is broken out and packed in slack barrels. After distillation of the latter Aroclor the receiver cover must be removed and this vessel thoroughly cleaned since a small amount of this Aroclor always remains and contamination of the other Aroclors with this would render them unsaleable. A separate receiver would be of great value here.

<u>Operating Difficulties</u>

1. Lime sludge settles to the bottom of the charging tank and sometimes plugs the outlet. This delays charging and if the amount of still residues in the still is low they may freeze.

2. Freezing of the still residues may result from several causes;

a. Slow charging as noted above.
b. Foreign matter such as iron shavings in the Quimby pump which will stall the screws.
c. Gradual wear in the barrel of the Quimby pump which reduces the capacity thereof and thereby causes carbonization in the coils.
d. Power interruption near or at the end of the run when there is nothing in the still but high melting residues. When distilling the solid Aroclors power interruptions at any time during the run is serious.
e. Drawing still residues so rapidly that the flow through the coils is low enough to cause carbonization.

When a freeze occurs due to foreign matter in the pump it is generally necessary to re-condition the pump, making new screws and re-grinding the barrel. This job costs approximately $100.00. In addition, all lines to and from the pump must be taken down and cleaned out. Any still residue left in the kettle generally stays molten long enough to allow this to be drawn off as a liquid. Most interruptions of this kind have been traced to pump failure, and the use of a satisfactory type of centrifugal pump here would eliminate a great deal of trouble from this source. If a power interruption occurs it is sometimes possible for the operator to prevent a freeze by drawing all the material from the still through the valve at the pump discharge. However, the residues harden very rapidly and the operator must work fast.

3. If the solid Aroclors, particularly 1268, are allowed to enter the receiver too hot they tend to sublime and solidify at the first constriction in the vacuum line, thus causing low vacuum. It is difficult to entirely prevent this since it is necessary to keep the distillate molten. However, much delay from this source will be prevented if the operator cleans out the fittings at the head of the dome after each batch.

4. Due to gradual abrasion it is necessary to recondition the Quimby pump once or twice annually depending on the continuity of operation.

The following table shows the factors involved in the distillation of the various Aroclors.

Aroclor No.	Charging Temperature °C	Charged per Batch (Lbs.)	Operating Pressure (mm)	Range at Operating Pressure °C	Range at Atmospheric Pressure °C	Sp. Gr. M. P. S. P.	% Recovery	Capacity Per Day
1242	100 - 125	1,000	1 - 3	180 - 210	311 - 388	1.388 @ 65/65	96 - 97	3,000 #
1248	100 - 125	1,000	1 - 3	200 - 230	331 - 358	1.459 @ 65/65	96 - 97	3,000
1254	100 - 150	1,000	1 - 3	210 - 245	363 - 378	1.532 @ 65/65	96 - 97	3,000
1260	125 - 150	1,000	1 - 3	225 - 255	372 - 397	1.610 @ 90/90	96 - 97	3,000
1262	125 - 150	1,000	1 - 3	220 - 280	373 - 404	1.635 @ 90/90	96 - 97	3,000
1268	200	1,000	1 - 3	240 - 270	Not Determined	150° C.-M. P.	95 - 98	3,000
4465	150	1,000	1 - 3	235 - 350	Decomposes	71 - 75° C. S.P.	88 - 90	2,000
5460	175	1,000	1 - 3	250 - 350	Decomposes	112° C S.P.	80 - 85	1,500

Notes

Sp. Gr. - Specific Gravity

M. P. - Mold Point

S. P. - Softening Point

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Shipping Containers

Vacuum distilled Aroclors are packed in the following types of containers:

Liquid Aroclors:

1. 18 gauge Galvanized Iron Drums - 50 gallon capacity, 22½" dia. by 31-3/4" high, with 2" bung and 3/4" vent in head.

2. 18 gauge Galvanized Drums - 50 gallon capacity, same length and diameter as above without bungs but with 12" 12-bolt cover in head.

3. 18 gauge Galvanized Iron Drums - 30 gallon capacity, 18-1/4" dia. by 29-3/4" high with 12" 12-bolt cover in head, no bungs.

Aroclors 4465 and 5460:

1. 26 gauge Galvanized Steel Cans - 38 gallon capacity, 18-1/4" O. D. by 35" high with 9 inch friction top.

Aroclor 1268:

1. Slack Barrels with liners.

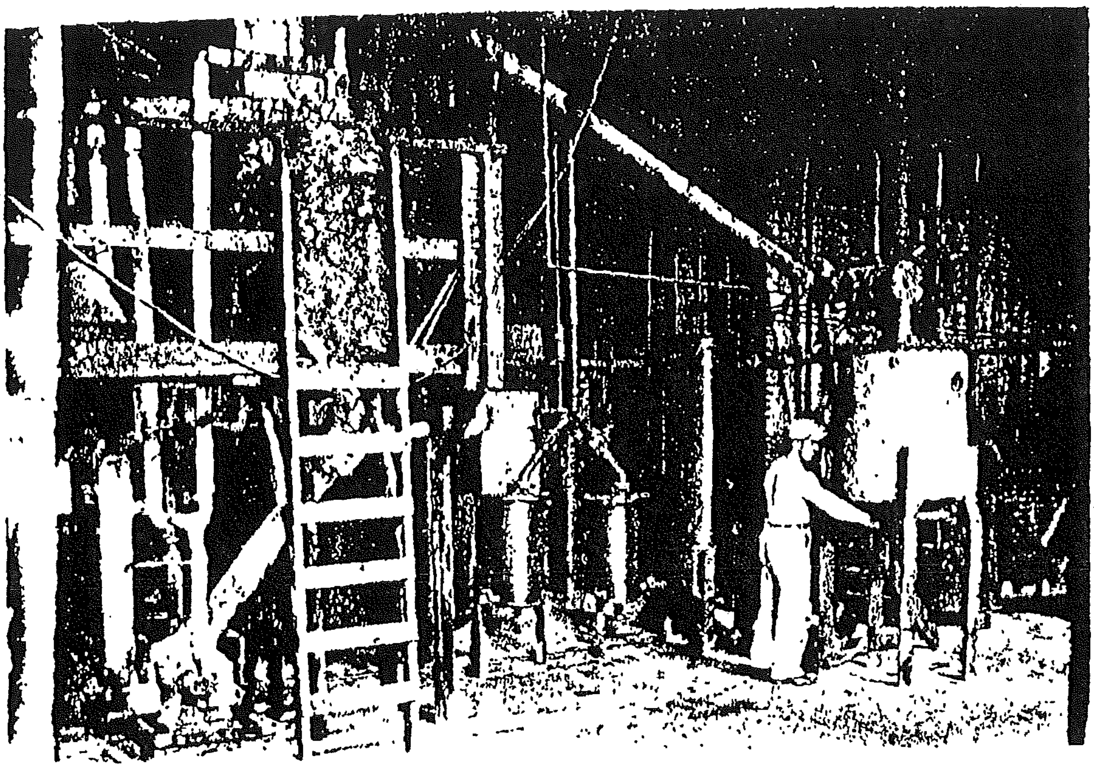
This Aroclor is shipped both lump and pulverized, one customer requiring the latter. The milling is done in a swing hammer mill. This operation is very difficult in warm weather since the Aroclor tends to soften and stick due to friction in the mill.

In addition to the above, samples and less drum orders are repacked in 2, 4 and 8 oz. screw top bottles; one pint, one quart and one half gallon friction top cans; three and five gallon friction top wood-sheathed cans and five gallon square wood-boxed screw-top cans. An attached table gives the weight capacity of each of these containers for the different Aroclors.

DIPHENYL AND AROCLOR SHIPPING CONTAINER CAPACITIES

Product	1/2 Gal. Can	3 Gal. Round Can	5 Gal. Round Can	5 Gal. Square Can	30 Gal. Galvd. Drum	50 Gal. Galvd. Drum	25 Ga. Galvd. Can	25 Ga. Black Can	50 Gal. Steel Drum	Black Barrel	Bags
1242	5 - 6	30-40		50-60	350	500-575					
1248	5 - 6	30-40		50-60	350	500-600					
1254	5 - 6	30-40		50-60	375	500-600					
1260	5 - 6	30-40		50-60	400	500-600					
1262	5 - 6	30-40		50-60	400	500-600					
1268	5	30	50							300-350	
1269	5	30	50							400	300
4465	5	30	50				500				
5460	5	30	50				500				
2565	5	30	50					425			
1242	5 - 6	30-40		50-60					500		
1248	5 - 6	30-40		50-60					500		
1254	5 - 6	30-40		50-60					500		
1260	5 - 6	30-40		50-60					500		
1262	5 - 6	30-40		50-60					500		
Diphenyl	5	15	25							275	

DSW 001392



BADGER STILL

Used for distilling all Aroclors except 1269. Left below - Quimby circulating pump. Above - Gas fired coil heater. Left center - Still tank showing lower part of foam trap. Right center above - Condenser. Below - Vacuum traps and scrubbers. Right - Product receiver.

DSW 001393

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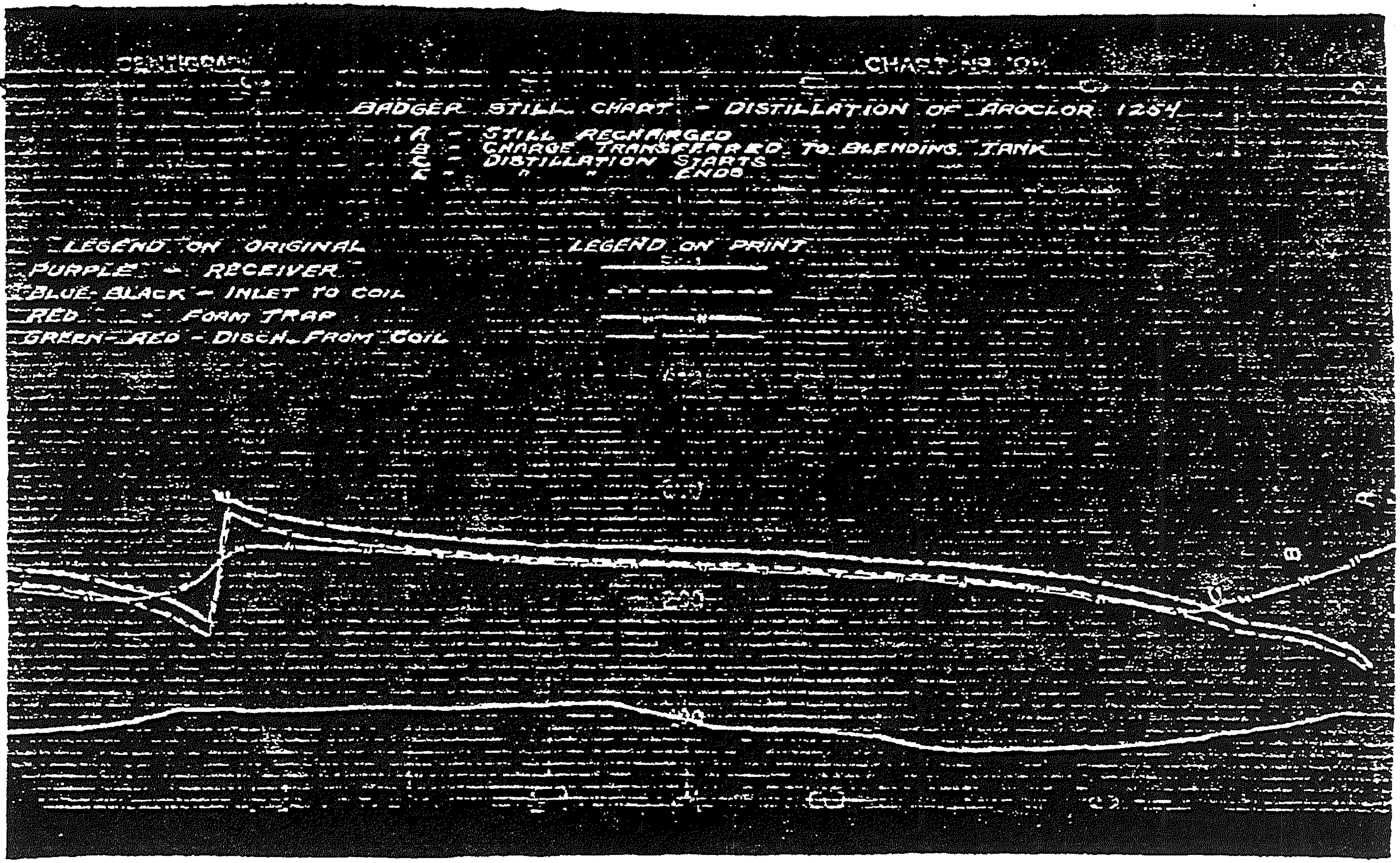

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OPERATION OF BADGER STILL

Aroclor No. [illegible]

Batch No. 2 Lot No. [illegible]

Inches Charged 17"

Pounds Dist'd. Not Used

Pounds Still Bottoms

Distillation Started 6:30 P. M.

Vac. on 6:15 P. M.

Date [illegible]

Operator [illegible]

Shift No. [illegible] From 3:00 AM / PM

To 11:00 AM / PM

Time	PRESSURE M. M. Kettle	PRESSURE M. M. Receiver	Aroclor Batch No.	Aroclor Drum No.	Charged Weight	B. No. Drum No.	Aro. Weight	Recd. Checked By
6:30		4	212	5	679			
7:00		2	212	6	[illegible]			
7:30		2	L. A.		T. C. W.			
8:00		2						
8:30		2						
9:00		2						
9:30		2						
10:00		2						
10:30		2						
11:00		2						
11:30		2						
12:00		2						
12:30		2						
1:00		2						
1:30		2	Run Complete 1:30 A.M.					

DSW 001395

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DIPHENYL AND AROCLOR OPERATING FORCE

Personnel

The attached organization chart shows the men necessary for operating the plant when in full operation. Under the Code it is necessary to have at least four men for each job. These men work as follows:

	Thurs.	Fri.	Sat.	Sun.	Mon.	Tues.	Wed.
Shift 1	Man - 4	Man - 4	Man - 1	Man - 1	Man - 1	Man - 1	Man - 1
Shift 2	Man - 2	Man - 2	Man - 4	Man - 4	Man - 2	Man - 2	Man - 2
Shift 3	Man - 3	Man - 3	Man - 3	Man - 3	Man - 4	Man - 4	Man - 3

This lineup holds for two weeks, then the shifts change forward, man #1 taking the place of man #4, who has been on floating shift, while man #4 takes the afternoon shift. Men #2 and #3 take the midnight and day shifts respectively. This gives each man an average of 42 hours per week over an eight-week period, but the intermittent character of these operations permits bringing the average down to 40 hours in the course of a year. For continuous operation it would be necessary to have more experienced operators to keep the average down to forty hours. All day shift men are kept to forty hours per week when possible, but never above forty eight.

Duties

Unit Operator

This man is in charge of his shift on diphenyl and crude aroclor production. His duties are as follows:

1. See that sufficient benzol for operation is kept in feed tanks.
2. Regulate feed to converter unit.
3. Take hourly samples of diphenyl-benzol solution from column and determine diphenyl content, by distillation, thus checking conversion.
4. Pump diphenyl-benzol solution to benzol still and distil the benzol.
5. Operate diphenyl still.
6. Operate high-boiler still.
7. See that converter unit temperatures are correct.
8. Record all data on diphenyl operation as shown on the attached operating data sheet.
9. Perform any maintenance that he is capable of and which does not have to be referred to the Plant Maintenance Crew. This includes changing distributors when necessary.

One operator only is necessary when the unit is running smoothly but one man should never be left alone on this job. For this reason the unit and the chlorinators are always operated simultaneously when possible.

Chlorinator Operator

1. Pump raw diphenyl to chlorinator.
2. Regulate chlorine flow.
3. See that chlorinator temperature is correct.
4. Make density, hold point or softening point determinations to ascertain progress of chlorination.
5. Pump chlorinators when batch is finished.
6. Operate hydrochloric acid plant.
7. Fill acid tank cars.
8. Assist unit operator whenever needed.
9. Assist with, or perform small maintenance jobs.

Badger Still Operator

1. See that sufficient crude Aroclor is always on hand to keep still operating. (This is the duty of the day shift man).
2. Charge melting tank which supplies crude to still.
3. Transfer finished batches from receiver to blending tanks.
4. Fill shipping containers with finished Aroclors and store filled containers.
5. Keep premises around still and accessories clean.

Helpers

1. Charge melting pot with diphenyl for chlorination.
2. Break out diphenyl from pans after distillation.
3. Pack diphenyl for shipment.
4. Pack and store crude Aroclors.
5. Handle crude Aroclor drums for distillation.
6. Help fill carboys with hydrochloric acid.
7. Keep premises clean.

Aroclor 1269 Operators

1. See that still charges are broken up, weighed correctly and charged to the stills. The day operator has two helpers so that charges for all three shifts may be broken out on the day shift.
2. Operate stills and flaker.

Health and Welfare of Operators

In May, 1938, the operators in distilled Aroclors, both Badger and 1269, began to develop a severe type of dermatitis. At that time ventilation facilities in both operations were most inadequate and the men were exposed to dust and fume from the hot Aroclors. However, several of the men had been subject to the same exposure for three years previous to this and had suffered no ill effects. At about the same period the electrical properties of the distilled Aroclors began to fall below specifications, therefore it was assumed that some impurity, hitherto not present, was causing the trouble. Investigation revealed that the benzol then in use contained appreciable quantities of paraffin, which when pyrolized with benzol produced styrene as an impurity in the diphenyl. When the diphenyl was chlorinated, styrene dichloride was also formed. This compound is exceedingly unstable, giving up hydrochloric acid very readily. The theory developed from these findings, and almost certainly borne out by circumstances, was that the styrene dichloride entered the pores of the skin with Aroclor vapor and finely divided dust where it decomposed. The acid formed acted as an irritant, infection set in and the skin disease resulted.

Skin specialists were consulted, but cure of the disease was found to be slow and difficult. The company became involved in an expensive litigation since suit was entered by the majority of the men affected.

As a result of this trouble the following precautionary measures were taken.

1. All affected men were removed from the operation and new men substituted as rapidly as they could be trained.

2. Adequate ventilation facilities were installed. DSW 001398

3. A complete change of clean clothing was and still is furnished to each man daily.

4. Towels, soap, alcohol and cold cream are also furnished. Each man is required to rub his face, neck and arms with cold cream before going to work and to take a thorough bath and rub himself with alcohol after work.

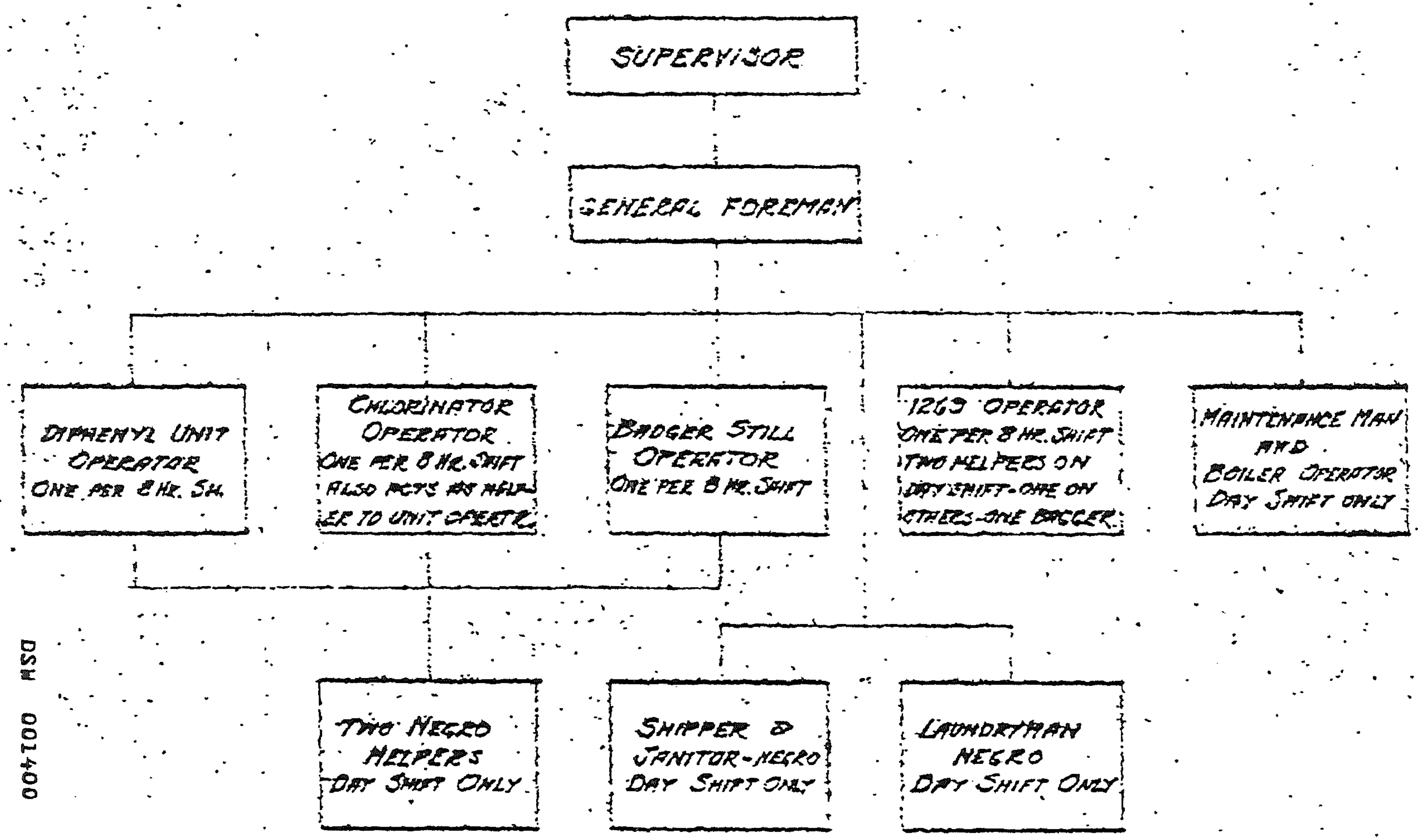
5. The men are examined regularly by the Plant Physician.

6. No man who shows a tendency to dermatitis is employed in the Department.

7. Rigid specifications were set up for benzol so that there could be no reoccurrence of styrene.

As a result of these precautions there has been no reoccurrence of dermatitis among the operators.

DIPHENYL AND AROCLOR ORGANIZATION CHART



DSW 001400

ADA 000753

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WATER_PCB-SD0000045920

PACKING, GASKETS AND OTHER ACCESSORIES USED IN DIPHENYL AND AROCLOR MANUFACTURE

<u>Goetze No. 2 Corrugated Copper Asbestos Gaskets - Suitable Sizes</u>

1. Dephlegmating Column Head and Bottom
2. Dephlegmator and Condenser Flanges
3. Benzol Still Flanges
4. Diphenyl Still Flanges
5. Lectrodryer Cooler and Condenser Flanges
6. High Boiler Still Flanges
7. Flanges on Chlorinators and Traps
8. Badger Still Flanges

<u>Johns-Manville Centripac - Style C-7</u>
1. Benzol Pumps
2. Coil Glands on Lectrodryer

<u>Pigskin</u>
1. Heads and Bottoms of Dephlegmator and Condenser
2. Column Head on Benzol Still
3. Column Head on Diphenyl Still
4. Cover and Plate on Lectrodryer
5. Column Head on High Boiler Still
6. Chlorinator Heads and Distributor Flanges
7. Iron Flanges at bells on HCl Cooler
(Goetze No. 2 Copper Asbestos Gaskets are recommended as replacements at all these points except 7 and 8.)

<u>Goetze No. 1200 Corrugated Steel Asbestos Gaskets</u>
1. Converter Unit Goosenecks

<u>Annealed Copper Wire - 5/16" Diameter</u>
1. No. 2 Preheater Cover Gasket

<u>Braided Asbestos Rope - 1" Diameter</u>
1. Converter Cover Gasket

DSW 001401

Twisted Asbestos Rope
1. Melting Pot and Blowing Tank Covers
2. Water Gland on Hcl Cooler
3. Cylinder Heads on Chlorine Vaporiser
4. Cover Gaskets on 1289 Distillation Pots
5. Cover on Badger Still Charging Pot

Q.O.P. Composition Packing - Manhattan Rubber Co.
1. Glass Gauges on Feed and Sump Tanks
2. U-Bends on Cooler Tubes - Hcl Plant

Belmont Asbestos Jacket Tape #549 - (Young & Vann Hardware Co.)
1. Heads on Benzol Still Steam Chest.

Acetylene Hose
1. Receiver Cover on High Boiler Still

Johns-Manville MX-1242 Ring Packing
1. Centrifugal Pumps Handling Crude Aroclor and Diphenyl
2. American Marsh Centrifugal Pump on Badger Still
   Hot Aroclor circulating system.

Goetze French Type Lead Asbestos Gaskets
1. Sight jar on Badger Still

Acidolor Putty
1. Vitreosil Absorbers and Coke Towers - Hcl Plant

Sheet Rubber
1. Dust Collector Flanges and Cone above Collecting Barrel
2. Trap Cover on High Boiler Still
3. Cover on Badger Still Receiver

John Crane Style 150 Metallic Packing
1. Quimby Pump Packing (Badger Still)

Garlock Ring Packing
1. Crane Regrindable Seat Valves on Chlorine Vaporiser

Henry Johnson Style RS
1. All Globe and Gate Valve Stems other than those with
   regrindable seat.

DSW 001402

Prezeal Spirals - 1-1/4" Diameter
1. All Distillation Columns

Coke
1. Towers at Hcl Plant
2. Acid Traps on Badger Still

SEC. 3
3

DSW 001403

ADA 000756

SECTION NO. B

HEAT BALANCE ON PRESENT DIPHENYL CONVERTER UNIT

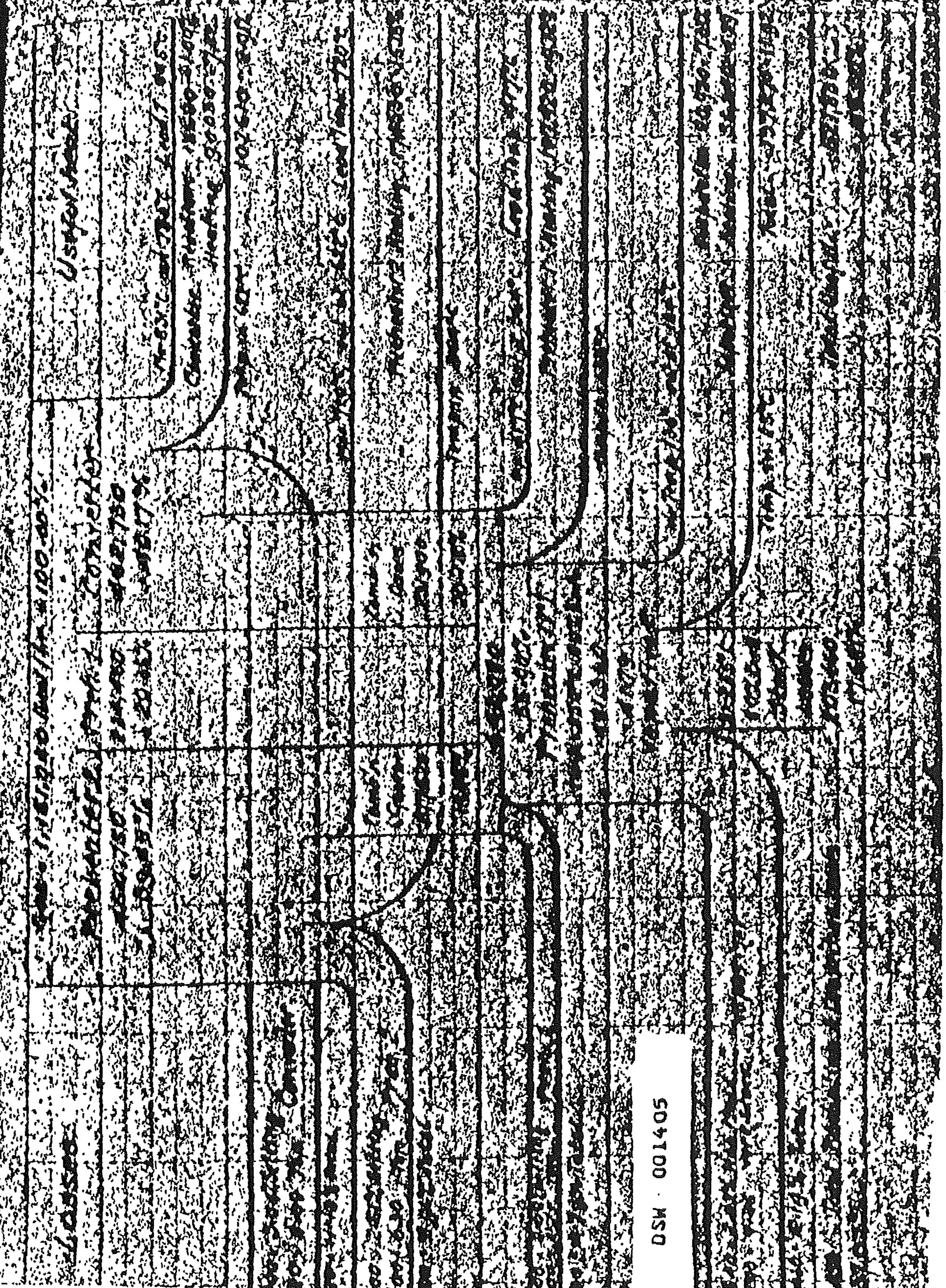
Y. V. ANDREAE
ENGINEERING DEPARTMENT

DSW 001404

ADA 000757

HEAT BALANCE

DIPHENYL UNIT AT ANNISTON



DSW 001405

ADA 000758

HEAT BALANCE OF DIPHENYL UNIT AT ANNISTON, ALABAMA

A test on the 5 Pot lead bath Diphenyl Unit was made on May 22, 1935.

The purpose of this test was to ascertain pertinent facts regarding the heat balance on the basis of present operations. The facts to be brought out by this test were desired in supplying data for the design of a more efficient Unit.

The test lasted 6 hours from 9:45 A.M. to 3:45 P.M.(May 22, 1935) and the following determinations were made.

1. Gas Consumption
2. Temperature of the Benzol at various points
   Temperature of the lead in the pots
   Temperature of the side walls of the Unit at various points
   Temperature of Combustion Gases
3. Amounts of Benzol fed and returned and production
4. Pressures in the various pots.

The attached Print gives a clear picture of the heat balance showing the heat distribution and the temperatures of the gases at important points.

The efficiency of the Unit as operated at Anniston is 45.50%, based on a consumption of 2.22 cu. ft. of gas per lb. of processed Benzol. In other words 45.5% of the total heat content of the gas is found in the gases leaving the converter.

The figures used for the thermal properties of Benzol are based on the formula given in Perry's Handbook on the bottom of p ge 549.

No data was available to check the formula:

1. Gas Consumption

Converter pot - 6 burners on and off	874.9 cu.ft./hr.
Preheater No. 2-8 " " " "	859.8 " " "
Preheater No. 1-2 " continuous	443.3
Total	2178.0
Low heating value of gas	528.9 # cal./cu.ft.
Total heat in gas	1,151,940 lb.cal./hr.

DSW 001406

2. Temperatures

Measured

Benzol leaving Vaporizer	156°C	By means of Tapalog
Preheater #1	570	
" #2	525	
Converter	720	
Lead Preheater #1	417	
" #2	720	
Converter	845	

After checking the instruments and on the basis of the requirements of the heat balance, the following temperatures were chosen for the benzol at various points.

Benzol Feed	25°C
Benzol leaving Vaporizer	156
" entering Preheater #1	154 (2° drop in pipe)
" leaving lead Preheater #1	417
" " Preheater #1	370
" entering Preheater #2	364 (6° drop in conn. pipe)
" leaving lead Preheater #2	710
" leaving Preheater #2	630*
" entering Converter	622 (8° drop in conn. pipe)
" leaving lead Converter	831
" leaving Converter	730
Reaction assumed to take place @	730°C

* The reading of the Tapalog at this point was 525°C, but was found to be in error.

Temperature of combustion gases before and after the vaporizer:

Before 550°C % CO_2 6.5° O_2 9.82% (80% Exc. Air)
After 255°C

3. Benzene Feed and Return & Production

Amounts of benzene fed	981#/hr.
returned	697
processed	284
Products Measured	228
91% Diphenyl & H.B.	208
9% Benzene	20
Hydrogen (calculated)	5
Benzene carried by Hydrogen(Calc.)	25
Total Products measured & calc.	258
Unaccounted for	26#/hr.

DSW 001407

There was a small leak on top of the converter which might explain the difference.

ADA 000760

4. Pressures

From the height of the lead in the 3 pots the pressure can be calculated. The height of the lead was not measured but taken from operating data.

	Calculated	Measured
Top of Converter	1 lb.	1 lb.
Pressure of Converter 39" of lead	15.8 lbs.	
At top of Preheater #2	16.8	16.5
Pressure of Preheater #2 45" of lead	17.9	
At top of Preheater #1	34.7	37.0
Pressure of Preheater #1 47" of lead	18.7	
Pressure of feed line	53.4	49.0

The temperature of the Benzol leaving the Vaporizer was 136° corresponding to 58.5 absolute or 43.8 gauge. There is probably a small error in the temperature reading and perhaps also in the height of the lead as reported.

FVA/jw
6/18/35

DSW 001408

ADA 000761

SEC. 4
4

DSW 001409

ADA 000762

SECTION NO. 4

COST SHEETS FOR MAY 1955 WHICH GIVE DETAIL COSTS ON DIPHENYL AND DIPHENYL DERIVATIVES BOTH FOR MAY AND AVERAGE COSTS FOR PREVIOUS MONTHS

DSW 001410

SWANN CHEMICAL COMPANY

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SYMBOL PAGE NO.			
	13 - DIPHENYL		
6 1300	DIPHENYL TECHNICAL		
6-1301	HIGH BOILER DISTILLED		
	14 - AROCLORS		
6-1400	CRUDE AROCLOR - TOTAL		
	1401	AROCLOR #	1119
	1403	AROCLOR #	1142
	1405	AROCLOR #	1148
	1406	AROCLOR #	1150
	1407	AROCLOR #	1154
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	1416	AROCLOR #	3165
	1420	AROCLOR #	4065
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6 1430	DISTILLED AROCLOR - TOTAL		
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	1435	AROCLOR #	1248
	1436	AROCLOR #	1250
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	1440	AROCLOR #	1264
	1442	AROCLOR #	1268
	1443	AROCLOR #	1269
	1450	AROCLOR #	4465
	1453	AROCLOR #	5450
	1452	AROCLOR #	5442
6-1460	AROCLOR COMPOUND		

DSW 001411

ADA 000764

78% of Di
14% of Hi
92.7% Total

DSW 001412

ADA 000765

WATER_PCB-SD0000045932

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INV. BLDGS. $ [illegible] EQUIP. $ [illegible].20 PRODUCT DIPHENYL

INV. TOTAL $ [illegible] SYMBOL SCH 6-1300 MONTH OF May 1935

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1934 Per Lb.
[illegible] 22,[illegible]							
[illegible]							
[illegible] (Capacity) 01	106.80 / 99,000		67.65 / 261,057		68.58 / 665,836		
[illegible] (GI)(122,000 lbs)	16,634	.187	48,779	.187		.214	.216
LEAKAGE LOSS						.008	.008
[illegible] BOILER (NO 6)	23,111	.260	70,755	.269			
BENZOL	2,499.10	2.808	7,389.18	2.830		4.072	4.240
Total Raw Materials	2,499.10	2.808	7,389.17	2.826		4.072	4.240
Supervision	107.46	.121	237.66	.091		.015	.018
Labor	368.28	.414	1,066.19	.417		.494	.491
Maint. Labor	284.93	.320	1,145.50	.439		.300	.573
Material	152.16	.171	512.21	.342		.250	.499
Maint. Labor INTRA PLANT						.012	.012
Material						.010	.009
Tools and Supplies	89.88	.101	194.51	.075		.112	.116
[illegible] 10 Filter Cloth	224.63	.252	[illegible]	.231		.301	.301
Water	24.00	.027	96.00	.037		.047	.047
Fuel 16 Electrodes or Fuel Oil	250.35	.281	471.58	.181		.236	.233
[illegible] 17 Stocking	25.01	.028	52.60	.020		.051	.050
[illegible]	320.94	.361	843.19	.324		.422	.420
[illegible]	13.60	.016	39.43	.015		.018	.019
Direct Conversion	1,861.74	2.092	5,681.97	2.180		2.258	2.796
General Plant	175.07	.197	714.43	.274		.300	.404
Development	126.16	.142	126.16	.048			
Insurance and Taxes	138.44	.156	437.35	.156		.156	.300
Depreciation	1,062.11	1.193	3,133.57	1.199		1.199	2.647
Indirect Conversion	1,502.18	1.688	4,377.91	1.677		1.655	3.351
Total Conversion	3,368.92	3.785	10,067.88	3.857		3.918	6.14[illegible]
Manufacturing Cost Bulk	5,868.02	6.593	17,457.06	6.687		7.9[illegible]	10.3[illegible]

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels	2,200	6.97		2,800	19.60	.545
Labor		2.64			5.64	[illegible]
Kegs Cans	110	7.01		441	13.40	[illegible]
Labor						
Bags Cartons 34 Carboys	3			4		
Labor 34a Labor						
Tank Cars For. Ship.						
Labor [illegible]						
Labor Storing BULK STORING		21.78			93.78	.036
Maint. Storage Equip. & Bldgs						
Loss in Repacking						
Total Packing Cost	2,313	33.40		2,645	130.82	
Dunnage		.88			2.20	[illegible]
Drayage						
Labor Tank Cars						
Labor Car Loads	2,313			5,619		
Labor LCL						
Switching & Weighing						
Total Shipping Cost	2,313	.88	.038	5,619	2.20	[illegible]

	Pounds	Bulk Amount	Per Lb.	Pounds	Packed Amount	Per Lb.
Minimum Inventory						
Opening Inventory	8,010	605.57	7.561			
Transferred In		71.78				
Produced	89,000	5,868.02	6.593	2,313	166.49	7.198
Total to Account For	97,010	6,545.37	6.696	2,313	166.49	7.198
Closing Inventory	27,397	1,834.37	6.696			
Disposed of	69,613	4,660.75	6.696	2,313	166.49	7.198
Shipped [illegible]				2,310	165.72	[illegible]
[illegible]				2,310	164.70	7.130
[illegible]				3	.22	7.198
Used						
6-1407.01-1300	39,800	1,995.26	6.696			
6-1413.01-1300	35,500	2,376.91	6.696			
53-1606 [illegible]	2,000	133.91	6.696			
	2,313	154.87	6.696			

DSW 001413

ADA 000766

WATER_PCB-SD0000045933

EST. BLDGS. $ 2,[illegible] EQUIP. $ 6,0[illegible]7. PRODUCT DISTILLED III BOILER 127
EST TOTAL $ 8,[illegible].30 SYMBOL SCH 6-1301 MONTH OF May 1935

	This Month Amount	Per Lb	Year to Date Amount	Per Lb	Budget Amount	Per Lb	103 Per Lb
[illegible] DI	8,548		36,188		30,000		
[illegible] III BOILER (NO VALUE)	11,660	1.303	47,527	1.313		1.454	.258
[illegible] Raw Materials			22[illegible]	.[illegible]		.003	.870
Supervision	27 82	.311	101 72	.281		.271	1.197
[illegible]	17 55	.140	55 17	.150		.098	1.230
[illegible] Labor			5 76	.016		.022	.534
Material							.013
[illegible] Labor							
Material							
[illegible] and Supplies	7 75	.087	16 25	.241		.032	.175
[illegible] Cloth — 10 Filter Cloth			99 14	.274		.363	1.190
[illegible]	6 00	.067	16 [illegible]	.044		.037	.058
[illegible] — 16 Electrodes or Fuel Oil			4 [illegible]	.012		.018	.095
[illegible] — 17 Stocking			46 74	.129		.171	.207
[illegible]							.031
[illegible] Conversion	54 77	.605	25 34	.974		1.095	5.699
[illegible] Plant	12 98	.145	14 58	.178		.300	.363
[illegible]						.300	
[illegible] and Taxes	26 54	.300	1[illegible]	.300		3.328	
[illegible]	297 79	3.328	1[illegible]	3.[illegible]		3.928	.363
[illegible] Conversion	337 61	3.773	1[illegible]	3.862		5.023	6.062
[illegible] Conversion	391 78	4.378	1,72[illegible]	4.770		5.023	6.062
[illegible] Cost Bulk	391 78	4.378	1,7[illegible]	4.7[illegible]			

Packing and Shipping Cost	This Month Pounds	Amount	Per Lb.	Year to Date Pounds	Amount	Per Lb
[illegible]						
Labor						
[illegible] Cans	85	1 41		85	1 41	1.41
Labor						
[illegible] Cartons — 84 Carboys	5			5		
Labor — 84a Labor						
[illegible] Tot. Stop						
[illegible] 28 H. [illegible] Bulk Storage		5 28			[illegible] 38	1.[illegible]
[illegible] Storage Equip. & Bldgs.						
[illegible] Repacking						
[illegible] Packing Cost	90	6 49	7211	90	[illegible]	7211
[illegible] 14						
[illegible] 4.5						
[illegible] Tank Cars						
[illegible] Car Loads						
[illegible] LCL						
[illegible] & Weighing	90			90		
[illegible] Shipping Cost	90			90		

		Bulk			Packed	
[illegible] Inventory	38,531	1,[illegible]	5.309			
[illegible] Inventory	8,948	391 78	4.378	90	4 14	4.[illegible]
[illegible] Account For	37,479	2,054 57	5.481	90	4 19	4.[illegible]
[illegible] Inventory	37,339	2,043 76	5.481	88	4 [illegible]	4.[illegible]
[illegible]	190	10 41	5.451	85	4 97	5.847
				3	54	[illegible]

141-35

Int. Packing 90 4 93 5.478

S-1142-01-90 100 5 48 5.480

DSW 001414

ADA 000767

20,2[illegible] EQUIP. $ 12,486.05 PRODUCT CRUDE AROCLOR TOTAL 128

[illegible] BLDGS $ 32,692.13 SYMBOL 8CH 6-1400 MONTH OF [illegible] 195[illegible]

[illegible] TOTAL $

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	195[illegible] Per Lb.
[illegible]							
[illegible] Capacity	159,008		677,352				
[illegible]	1,192		14,177				
[illegible] AROCLOR	[illegible]		257,425				
DIPHENYL			8,350				
DISTILLED HIGH BOILER							
CHLORINE	444,889		839,213				
DIST. AROCLOR	534		634				
CRUDE AROCLOR			$ 1,598.67				
DIPHENYL	4,349.12		18,741.16				
DISTILLED HIGH BOILER			175.34				
CHLORINE	5,334.14		27,135.70				
DIST AROCLOR	56.19		649.42				
[illegible]	9,755.25		47,970.18				
[illegible]	206.14		596.43				.023
[illegible]	2,337.43		11,282.27				.230
[illegible]	83.54		648.13				.072
[illegible] Labor	64.26		192.03				.055
Material							.006
[illegible] Labor INTRA PLANT							
Material	45.12		252.14				.034
[illegible] Supplies							
[illegible] 10 Filter Cloth	2,012.32		985.13				.133
[illegible]	50.50		172.00				.023
[illegible]	58.68		308.33				.028
[illegible] 16 Electrodes or Fuel Oil	12.21		27.54				.006
[illegible] 17 Stocking	7.82		65.72				.007
[illegible]	21.47		135.73				.013
[illegible]							
[illegible] Conversion	7,027.96		23,634.50				.031
General Plant	140.51		664.05				.111
[illegible] 26 DIRECT WELFARE	63.27		425.71				.009
[illegible] and Taxes	35.55		144.31				.026
Depreciation	253.41		1,085.21				.193
[illegible] Conversion	443.16		1,877.50				.305
Total Conversion	1,465.86		6,246.78				1.017
Manufacturing Cost Bulk	11,221.11		47,166.68				

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels	14,660	27.42		29,100	26.51	
[illegible] Labor		1.42			2.42	
[illegible] Cans	3,600			77,073	210.11	
[illegible] Labor					6.12	
Bags Gallons 84 Carboys	11			34		
[illegible] Labor 84a Labor						
Tank Cars For Ship						
[illegible] 36 [illegible] USED IN STORING Bulk Storing [illegible]		28.45			734.11	
Labor Storing						
[illegible] Storage Equip. & Bldgs						
Loss in Repacking						
Total Packing Cost	18,311	37.59		126,457	445.59	
Dunnage 44		9.18			14.62	
Drayage 45						
Labor Tank Cars				40,558	8.50	
Labor Car Loads	11,311	8.36		38,292	15.89	
Labor LCL						
[illegible] & Weighing						
Total Shipping Cost	11,311	75.44		79,174	$ 39.31	

	Pounds	Bulk		Pounds	Packed	
Minimum Inventory						
Opening Inventory	105,264	$ 8,448.75	8.064	54,735	$ 3,975.16	7.265
Transferred in 53-1601.80		4.23		967	96.20	
Produced	159,008	11,321.81		10,866	1,122.71	
Total to Account For	264,272	19,774.34		65,998	5,070.33	
Closing Inventory	140,353	10,765.09		53,735	4,101.[illegible]	
Disposed of	123,919	8,881.25		12,263	967.25	
Shipped		$		12,273	$ 843.51	

Used [illegible]-1412-01-1405	175	10.72
[illegible]-1415-01-1421	500	23.50
[illegible]-1432-01-1411	567	41.10
[illegible] 1431 01-1407	57,907	3,877.97
[illegible] 01-1413	54,514	4,186.4[illegible]
	10,311	901.84

DSW 001415

2217

ADA 000768

WATER_PCB-SD0000045935

EST. BLDGS. $ EQUIP. $ PRODUCT CRUDE AROCLOR # 1110

EST. TOTAL $ SYMBOL SCH 6-1401 MONTH OF May 1935

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1934 Per Lb.
Per Day							
Per Year							
% of Capacity							
Section 01							
DIPHENYL							
CHLORINE							
1300 DIPHENYL							
931 CHLORINE							
Total Raw Materials							
Supervision							
Labor							
Repl. Labor							
" Material							
Maint. Labor							
" Material							
Tools and Supplies							
Filter Cloth 10 Filter Cloth							
Steam							
Power							
Water 16 Electrodes or Fuel Oil							
Oil 17 Stocking							
Gas			174				
Laboratory							
Direct Conversion			174				
General Plant							
Development							
Insurance and Taxes							
Depreciation							
Indirect Conversion							
Total Conversion			174				
Manufacturing Cost Bulk			174				

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels						
Labor						
Kegs Cans						
Labor						
Bags Cartons 34 Carboys						
Labor 34a Labor						
Tank Cars For Slag						
Labor						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost						
Dunnage 40						
Drayage 41						
Labor Tank Cars						
Labor Car Loads						
Labor LCL						
Switching & Weighing						
Total Shipping Cost		Bulk			Packed	
Minimum Inventory						
Opening Inventory	500	95 13	19.027	962	96 20	
Transferred In 53-1606						
Produced						
Total to Account For	500	95 13	19.027	962	96 20	
Closing Inventory	500	95 13	19.027	962	96 20	
Disposed of						
Shipped 7 Days				962	96 20	
				962	96 20	
Used						

DSW 001416

ADA 000769

ST. BLDGS. $	EQUIP. $	PRODUCT	SYMBOL SCH 6-1403	MONTH OF [illegible] 1935		
ST TOTAL $	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb	1934 Per Lb
Capacity	—		21645		36,470		
330 DIPHENYL			19200	.449		.595	.595
331 CHLORINE			25060	.845		.875	.875
330 DIPHENYL			1397 87	4.713		5.172	5.875
331 CHLORINE			656 20	2.214		2.406	2.116
Raw Materials			2053 57	6.937		7.578	7.991
			23 11	.080		.002	.004
			29 74	.101		.200	.221
			9 40	.032		.150	.142
			2 84	.010		.100	.050
Supplies			11 49	.039		.035	.037
Filter Cloth — 10 Filter Cloth			41 40	.140		.100	.117
			6 49	.022		.020	.020
Fuel Oil			3 95	.013		.001	.001
17 Stocking			2 20	.007		.005	.005
			33 10	.111		.010	.006
			164 57	.555		.623	.605
Conversion			16 57	.056		.080	.102
General Plant			6 21	.021			.156
26-DIRECT WELFARE			6 56	.022		.021	.013
Insurance and Taxes			44 09	.149		.150	.098
Depreciation			76 19	.257		.259	.371
Total Conversion			240 76	.812		.882	.976
Manufacturing Cost Bulk			2294 33	7.749		8.460	8.967

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb
Barrels						
Labor				5,503	63 35	1.151
Cans				6		
Cartons — 84 Carboys, 84a Labor						
Labor Storing — Bulk Storing					5 58	.019
Total Packing Cost				5509	68 93	—
Cartage 44		18			2 3	.041
Drayage 45						
Labor Car Loads						
Labor LCL	500	37		5,006	78	.116
Switching & Weighing						
Total Shipping Cost	500	55	.110	5,006	2 81	.056

	Bulk Pounds	Amount	Per Lb.	Packed Pounds	Amount	Per Lb
Opening Inventory	4,582	360 12	7.859	4,506	394 07	8.747
Total to Account For	4,582	360 12	7.859	4,500	394 07	
Closing Inventory	4,582	360 12	7.859	4,000	350 28	
Disposed of				500	43 79	
Shipped 7 Drums				522	39 75	1.740
				500	4 87	
Used						
Cost of Sales Adj. 1011 Last Month					34 38	
					22 52	48.75

DSW 001417

ADA 000770

WATER_PCB-SD0000045937

INVEST. BLDGS. $ EQUIP. $ PRODUCT CRUDE AROCLOR # 1148 131

INVEST TOTAL $ SYMBOL SCH 6-1405 MONTH OF [illegible] 19__

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb.	Budget Amount	Budget Per Lb.	19__ Per Lb.
Cap. Per Day							
Cap. Per Year							
Operated % Capacity							
Production .01			70,468		21,220		
1330 DIPHENYL			17,2[illegible]	.5[illegible]6		.519	.519
331 CHLORINE			21,750	1.038		.926	.926
1330 DIPHENYL			888 [illegible]	4.24[illegible]		5.261	5.261
331 CHLORINE			557 34	2.7[illegible]		2.272	2.272
Total Raw Materials			1,445 36	[illegible]		7.533	7.533
Supervision			27 [illegible]	.1[illegible]		.010	.0[illegible]
Labor			[illegible]	.1[illegible]		.176	.176
Maint. Labor			68 [illegible]	.324		.222	.222
" Material			14 [illegible]	.07[illegible]		.1.7	.1.7
Maint. Labor							
" Material							
Tools and Supplies			8 [illegible]	.039		.036	.036
Screen Cloth 10 Filter Cloth							
Steam			3[illegible]	.145		.152	.15[illegible]
Power			[illegible]	.0[illegible]		.033	.033
Water 16 [illegible]			[illegible]	.0[illegible]		.007	.007
Air 17 Stocking			3 [illegible]	.014			
Gas			11 [illegible]	[illegible]		.012	.012
Laboratory			1 [illegible]	[illegible]		.005	.005
Direct Conversion			2[illegible] 77	1.04[illegible]		.770	.77[illegible]
General Plant			42 [illegible]	.01[illegible]		.112	.112
[illegible] 25 DIRECT WELFARE							.16[illegible]
Insurance and Taxes			4 [illegible]	[illegible]		.021	.014
Depreciation			3[illegible]	.1[illegible]		.150	.2[illegible]
Indirect Conversion			[illegible] 76	.[illegible]		.29[illegible]	.417
Total Conversion			[illegible]	1.9[illegible]		1.[illegible]	1.187
Manufacturing Cost Bulk			1,738 [illegible]	8.491		8.594	8.72[illegible]

PACKING AND SHIPPING COST	This Month Pounds	This Month Amount	This Month Per Lb.	Year to Date Pounds	Year to Date Amount	Year to Date Per Lb.
Barrels						
Labor						
Kegs Cans				10	4 [illegible]	–
Labor						
Bags Cartons 34 Carboys						
Labor 34a Labor						
Tank Cars For Slag						
Labor 38 MATL USED IN [illegible] Bulk Storage					5[illegible]	1[illegible]
Labor Storing					4 [illegible]	[illegible]
Maint. Storage Equip & Bldgs						
Loss in Repacking						
Total Packing Cost				10	38 23	–
Dunnage 44						
Drayage 45						
Labor Tank Cars						
Labor Car Loads						
Labor LCL						
Switching & Weighing						
Total Shipping Cost						

	Bulk Pounds	Bulk $	Packed Pounds	Packed $
Minimum Inventory				
Opening Inventory	125	1074 8576	–	
Transferred In				
Produced				
Total to Account For	125	1072 8576		
Closing Inventory			10	91 91
Disposed of	125	1072 8576	1	
Shipped 7 [illegible] 2 [illegible]				77 / 77
Used 6-1413 - 01-1405	125	1072 8576		

DSW 001418

ADA 000771

WATER_PCB-SD0000045938

INVEST. BLDGS. $
INVEST. TOTAL $

EQUIP. $

PRODUCT SYMBOL CRUDE AROCLOR # 1150 SCH 6-1406 MONTH OF 7/ 1939

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb	1939 Per Lb
Per Day	—		—				
Per Year	—						
Capacity	—				86,560		
Production							
1330 DIPHENYL						.530	
931 CHLORINE						1.114	
1330 DIPHENYL						4.817	
931 CHLORINE							
Total Raw Materials						4.817	
Supervision						.097	
Labor						.018	
Maint. Labor						.002	
" Material						.002	
Maint. Labor							
" Material							
Tools and Supplies						.012	
Screen Cloth / 10 Filter Cloth							
Steam						.144	
Power						.050	
Water / 16 Electrodes or Fuel Oil						.009	
Air / 17 Stocking							
Gas						.006	
Laboratory						.031	
Direct Conversion						.371	
General Plant						.074	
Development							
Insurance and Taxes						.021	
Depreciation						.158	
Indirect Conversion						.253	
Total Conversion						.624	
Manufacturing Cost Bulk						5.441	

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb	YEAR TO DATE Pounds	Amount	Per Lb
Barrels						
Labor						
Kegs Cans						
Labor						
Bags Cartons / 84 Carboys						
Labor / 84a Labor						
Tank Cars Fce Slag						
Labor [illegible]						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost						
Dunnage						
Cooperage						
Labor Tank Cars						
Labor Car Loads						
Labor LCL						
Switching & Weighing						
Total Shipping Cost						
	Bulk				Packed	
Minimum Inventory						
Opening Inventory	4,059	359.66	8.861			
Transferred In						
Produced						
Total to Account For	4,059	359.66	8.861			
Closing Inventory	4,059	359.66	8.861			
Disposed of						
Shipped						
Used						

DSW 001419

ADA 000772

WATER_PCB-SD0000045939

...st BLDGS. $ EQUIP. $

...t. TOTAL $

PRODUCT CRUDE AROCLOR # 1154 — 138

SYMBOL SCH 6-1401 — MONTH OF [illegible] 193 5 / 193 4

	This Month Amount	Per Lb.	Year to Date Amount	Per Lb.	Budget Amount	Per Lb.	193 4 Per Lb.
... 01 (ADJ.)	70,949		193,944		717,934		
1X DIPHENYL	29,800	.420	71,080	.470		.467	.462
1X CHLORINE	76,200	1.074	209,560	1.081		1.106	1.116
2X DIPHENYL	1,995 26	2.812	6,723 11	3.471		4.129	4.680
3X CHLORINE	2,035 36	2.819	5,560 03	2.849		3.042	2.896
	4,030 62	5.681	12,259 14	6.321		7.171	7.576
... Valuables	47 12	.066	142 31	.073		.047	.059
...	113 87	.160	284 62	.148		.213	.212
...	37 04	.052	125 55	.065		.049	.061
... Labor	28 53	.040	47 74	.025		.064	.057
Material						.005	.004
... Labor							
Material							
... Supplies	20 42	.029	62 95	.032		.033	.034
... Cloth — 10 Filter Cloth	99 14	.141	269 54	.139		.159	.155
...	22 20	.031	54 47	.028		.019	.029
... 16 Electrodes or Fuel Oil	30 52	.043	53 15	.027		.026	.035
... 17 Stocking	5 55	.008	8 63	.004		.004	.004
...	3 47	.005	25 34	.013		.006	.006
...	5 83	.009	13 73	.007		.007	.006
... Conversion	414 14	.584	1,072 59	.553		.632	.672
General Plant	52 14	.073	145 27	.075		.090	.116
Equipment 26 DIRECT HELPAKE	17 57	.024	30 59	.016			.036
Insurance and Taxes	14 90	.021	41 33	.021		.021	.025
Depreciation	112 10	.158	308 54	.159		.159	.186
Indirect Conversion	197 51	.278	525 78	.271		.269	.305
Total Conversion	611 65	.862	1,597 77	.824		.901	1.037
Manufacturing Cost Bulk	4,642 27	6.543	13,856 71	7.145		8.072	8.613

PACKING AND SHIPPING COST	This Month Pounds	Amount	Per Lb.	Year to Date Pounds	Amount	Per Lb.
Materials						
Labor						
Steel Cans				1,103	1 30	.117
Labor				1		
Paper Cartons — 84 Carboys						
Labor — 84a Labor						
Steel Cars For Shpg						
Labor, PAILS USED IN STORING					16 22	.014
Labor Storing — Bulk Storing		17 63			43 13	.032
Maint Storage Equip. & Bldgs.						
Cost in Repacking						
Total Packing Cost		17 63	—	1,104	70 57	—
Demurrage 44		18			18	.036
Prepaid 45						
Labor Tank Cars						
Labor Car Loads						
Labor LCL	500	37		1,101	78	.049
Switching & Weighing						
OTHER SHIP. EQUIP.						
Total Shipping Cost	500	55	.110	1,601	1 36	.152

	Bulk Pounds	Amount	Per Lb.	Packed Pounds	Amount	Per Lb.
Maximum Inventory						
Opening Inventory	6,027	503 20	8.349	500	44 71	8.942
Transferred In		13 68				
Produced	70,949	4,642 27	6.543			
Total to Account For	76,976	5,158 10	6.701	500	44 71	8.942
Closing Inventory	18,574	1,244 63	6.701	500	44 71	8.942
Disposed of	58,402	3,913 47	6.701			
Shipped 7 bbls 1 3...				500	45 08	10.150
				500	50 75	11.094
Used 6-1413-01-1407	500	33 50	6.701			
6-1437-01-1407	57,902	3,879 97	6.701			

DSW 001420

SHIP ... TO ... COST OF SHIP

ADA 000773

WATER_PCB-SD0000045940

INVEST. BLDGS. $ EQUIP. $ PRODUCT

INVEST TOTAL $ SYMBOL MONTH OF 193 19

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	BUDGET Per Lb.	Per Lb.
Total Raw Materials							
Supervision							
Labor							
Maint. Labor							
Maint. Material							
Repl. Labor							
Repl. Material							
Tools and Supplies							
Screen Cloth / 10 Filter Cloth							
Steam							
Power							
Water / 16 Electrodes or Fuel Oil							
17 Stocking							
Laboratory							
Direct Conversion							
Central Plant							
Development							
Insurance and Taxes							
Depreciation							
Indirect Conversion							
Total Conversion							
Manufacturing Cost Bulk							

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb.
Barrels						
Labor						
Kegs-Cans						
Labor						
Bags-Cartons / 34 Carboys						
Labor / 34a Labor						
Tank Cars-Fce. Slag						
Labor						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost						
Dunnage						
Drayage						
Labor-Tank Cars						
Labor-Car Loads						
Labor-LCL						
Switching & Weighing						
Total Shipping Cost						

	Bulk	Packed
Minimum Inventory		
Opening Inventory		
Transferred In		
Produced		
Total to Account For		
Closing Inventory		
Disposed of		
Shipped		
Used		

DSW 001421

Cost of Sales Adj. 1011 Last Month

ADA 000774

WATER_PCB-SD0000045941

EST. BLDGS. $ EQUIP. $ PRODUCT SYMBOL SCH 6-1409 MONTH OF 7/1/ 193 4

EST. TOTAL $

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	BUDGET Per Lb.	193 Per Lb.
Per Day							
Per Year							
% Capacity							
Net	—		15,581		21,457		
1330 DIPHENYL			62,001	.436		.401	.395
331 CHLORINE			19,950	1.281		1.269	1.291
1330 DIPHENYL			470 69	3.021		3.545	4.225
331 CHLORINE			527 79	3.355		3.487	3.306
Total Raw Materials			992 48	1.376		7.032	7.530
Supervision			14 25	.090			.033
Labor			27 31	.175		.345	.355
Maint. Labor			6 68	.043		.222	.200
" Material			2 10	.013		.126	.110
Maint. Labor						.004	.003
" Material							
Tools and Supplies			7 72	.050		.040	.045
Press Cloth 10 Filter Cloth			22 13	.142		.133	.133
Steam			5 11	.033		.018	.035
Power							
Water 16 Electrodes or Fuel Oil			1 72	.011		.017	.035
Air 17 Blocking						.002	.002
Oil			89	.006		.006	.006
Laboratory			1 73	.011		.003	.006
Direct Conversion			89 48	.574		.919	.960
General Plant			14 32	.092		.080	.155
Development 86 DIRECT WELFARE			5 71	.037			.090
Insurance and Taxes			3 72	.024		.021	.019
Depreciation			23 62	.152		.150	.150
Indirect Conversion			47 37	.304		.250	.414
Total Conversion			137 40	.877		1.170	1.385
Manufacturing Cost Bulk			1,130 28	7.253		8.210	8.912

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb.
Barrels						
Labor						
Kegs - Cans				1,018	16 58	1.633
Labor					10	.010
Bags Cartons 84 Carboys						
Labor 84a Labor						
Tank Cars Tox Ring						
Labor 38 PAILS USED IN STORING						
Labor Storing Bulk Storing					4 79	.029
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost				1,018	21 74	—
Dunnage 44						
Drayage 45					17	.017
Labor Tank Cars						
Labor Car Loads						
Labor LCL				1,015	14	.014
Switching & Weighing						
Total Shipping Cost		$		1,015	$ 31	.031

	Bulk Pounds	Bulk $ Amount		Packed Pounds	Packed $ Amount
Minimum Inventory					
Opening Inventory	250	$ 19 44	7.614	—	$
Transferred In					
Produced					
Total to Account For	250	19 04	7.614		
Closing Inventory	250	19 04	7.614		
Disposed of					
Shipped — 7 drums (Detrol)		$			$ 7 74 / 7 74
Used					
SHIP EXP TO COST OF SHIP					
Cost of Sales Adj. 1811 Last Month					7 74
Cost of Sales Adj. 1811 This Month					

DSW 001422

ADA 000775

WATER_PCB-SD0000045942

...ST BLDGS. $ | EQUIP. $ | PRODUCT SYMBOL: CRUDE AROCLOR # 1165, SCH 6-1411 | MONTH OF May 1935 | 18C

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1934 Per Lb.
...Capacity ...Oil			16720				
...phenyl			6450	.383			
...ine			11290	.677			
Biphenyl			503.69	.319			
Chlorine			555.50	.341			
Raw Materials			1,011.11	6.333			
Operation			24.50	.147			
Labor	4.28		37.25	.224			
Repair Labor			2.34	.014			
Material			.54	.003			
Labor							
Material							
Supplies			9.07	.054			
Filter Cloth			22.74	.136			
Power			.55	.004			
Steam / 16 Electrodes or Fuel Oil			2.84	.017			
17 Stocking			1.70	.010			
...lection			14.52	.087			
Direct Conversion	4.28		134.76	.806			
General Plant	1.10		26.87	.161			
Development							
Insurance and Taxes			3.55	.021			
Depreciation			21.22	.111			
Indirect Conversion	1.10		57.20	.343			
Total Conversion	5.38		191.76	1.149			
Manufacturing Cost Bulk	5.38		1,253.95	7.504			

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels						
Labor						
Bags Cans				10	.10	
Labor					.01	
Bags Cartons / 84 Carboys						
Labor / 84a Labor						
Tank Cars Foe. Slag						
Labor						
Labor Storing Bulk Storing					4.99	.030
Maint Storage Equip. & Bldgs.						
Lost in Repacking						
Total Packing Cost				10	5.60	
Demurrage 44					1.95	
Drayage 45						
Label Tank Cars						
Label Car Loads						
Label LCL				10		
Switching & Weighing						
Total Shipping Cost				10	1.95	

	Bulk Pounds	Amount	Per Lb.	Packed Pounds	Amount
Minimum Inventory					
Opening Inventory	1,015	66.62	6.855		
Transferred In					
Produced		5.38			
Total to Account For	1,015	75.00	7.389		
Closing Inventory	448	33.10	7.389		
Disposed of	567	41.90	7.389		
Shipped 7 R syo					2.66
Used 6-1413-c1-1411	567	41.90	7.389		

DSW 001423

ADA 000776

WATER_PCB-SD0000045943

EST. BLDGS. $ EQUIP. $

EST TOTAL $

PRODUCT SYMBOL: CRUDE AROCLOR # 1168 SCH 6-1412

MONTH OF [illegible] 195_

797

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb	Budget Amount	Budget Per Lb	195 4 Per Lb
Capacity / Lbs.	—		11,783		20,520		
Biphenyl			6,750	[illegible]		.348	.331
Chlorine			23,770	[illegible]		1.416	1.350
Biphenyl			[illegible]	[illegible]		3.077	3.668
Chlorine			[illegible]	[illegible]		3.894	3.530
Total Raw Materials			[illegible]	7.949		6.971	7.424
Supervision			[illegible]	[illegible]			.106
Labor			[illegible]	[illegible]		.122	.117
Maint. Labor			[illegible]	.014		.051	.055
Material			[illegible]	[illegible]		.009	.013
Repl. Labor						.033	.031
Material							
Tools and Supplies			607	[illegible]		.014	.015
Filter Cloth — 10 Filter Cloth			[illegible]	[illegible]		.196	.193
Steam			[illegible]	[illegible]		.033	.032
Power			[illegible]	[illegible]		.055	.057
Water — 16 Electrodes or Fuel Oil			[illegible]	[illegible]		.012	.012
Air — 17 Stocking			165	[illegible]		.021	.019
Gas			116	.010			
Laboratory							
Direct Conversion			[illegible]	[illegible]		.533	.560
General Plant			[illegible]	[illegible]		.090	[illegible]
Development			[illegible]	[illegible]		.061	.050
Insurance and Taxes			[illegible]	[illegible]		.154	[illegible]
Depreciation			[illegible]	[illegible]		.259	.462
Indirect Conversion			[illegible]	[illegible]		.512	1.092
Total Conversion			[illegible]	[illegible]		7.783	8.476
Manufacturing Cost Bulk							

PACKING AND SHIPPING COST	This Month Pounds	This Month Amount	This Month Per Lb.	Year to Date Pounds	Year to Date Amount	Year to Date Per Lb.
Bottle						
Labor						
Bags Cans					1775	.078
Labor						
Bags-Cartons 34 Carboys						
Labor 34a Labor						
Tank Cars Etc. Sing						
Labor [illegible] IN [illegible]					316	.011
Labor Storing — Bulk Storage						
Rental Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost					1591	
Dunnage [illegible]						
Drayage [illegible]						
Labor Tank Cars						
Labor Car Loads						
Labor LCL						
Switching & Weighing						
Total Shipping Cost						
Minimum Inventory		Bulk			Packed	
Opening Inventory	17506	138578	7.896			
Transferred In						
Produced						
Total to Account For	17506	138578	7.896			
Closing Inventory	17,506	138,578	7.896			
Disposed of						
Shipped						
Used						
Cost of Sales Adj. 1011 Last Month						

DSW 001424

ADA 000777

WATER_PCB-SD0000045944

INVEST. BLDGS. $ EQUIP. $

INVEST. TOTAL $

PRODUCT CRUDE AROCLOR # 1168 — SYMBOL Sol. C-1413 — MONTH OF May 195[illegible]

	THIS MONTH Amount	THIS MONTH Per Lb	YEAR TO DATE Amount	YEAR TO DATE Per Lb	BUDGET Amount	BUDGET Per Lb	195 4 Per Lb
Per Day							
Per Year							
Rated Capacity							
Production 01	88,839		233,858		508,500		
Cr. OF AROCLOR-1403-1411-1407	6192	.073	9,902	.041			
1350 DIPHENYL	35,500	.400	77,870	.333		.333	.333
331 CHLORINE	123,500	1.390	317,254	1.356		1.445	1.445
1437 DISTILLED AROCLOR # 1254	524	.006	524	.002			
1451 AROCLOR 1119 (DIPHENYL STEC.)							
CRUDE AROCLOR 1403-1411-1407	$ 84.12	.097	$ 263.65	.219			
1350 DIPHENYL	2,346.91	2.676	5,[illegible].48	2.25[illegible]		2.944	3.213
331 CHLORINE	3,214.78	3.913	8,145.74	3.612		3.974	3.607
1437 AROCLOR # 1254-1443	56.19	.063	56.19	[illegible]			
1451 AROCLOR # 1119 (DS)							
Total Raw Materials	5,817.20	6.547	15,142.22	6.312		6.910	6.993
Supervision	57.02	.066	216.15	.190		.072	.062
Labor	194.28	.219	402.[illegible]	.16[illegible]		.206	.206
Maint. Labor	46.15	.052	321.68	.134		.045	.045
" Material	35.73	.040	[illegible].37	.038		.048	.045
Maint. Labor						.005	.005
" Material							
Tools and Supplies	25.56	.029	312.46	.134		.029	.029
Screen Cloth 10 Filter Cloth							
Steam	124.87	.141	354.53	.147		.119	.119
Power	27.86	.031	64.25	.029		.020	.02[illegible]
Water 16 Electrodes or Fuel Oil	37.16	.042	102.77	.043		.025	.026
Air 17 Stocking	7.40	.008	13.32	.006		.010	.010
Gas	4.35	.005	15.[illegible]	.00[illegible]		.005	.005
Laboratory	4.66	.005	11.32	.005		.005	.006
Direct Conversion	567.22	.639	1541.73	.664		.522	.522
General Plant	79.24	.090	211.97	.088		.090	.090
Development 20-DIRECT WELFARE							.006
Insurance and Taxes	18.65	.021	50.24	.021		.021	.025
Depreciation	140.57	.158	381.04	.159		.158	[illegible]
Indirect Conversion	238.46	.269	643.27	.268		.270	[illegible]
Total Conversion	805.68	.908	2,185.40	.932		[illegible]	.802
Manufacturing Cost Bulk	6,6[illegible].5[illegible]	7.457	17,327.87	7.244		7.6[illegible]	7.79[illegible]

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb.
Barrels						
Labor						
Kegs Cans					11.75	.005
Labor						
Bags Cartons 34 Carboys						
Labor 34a Labor						
Tank Cars, Fog Bldg						
Labor DK STERLING [illegible]						
Labor Storing (Bulk Storing)		15.87	.018		47.07	.017
Maint. Storage Equip. & Bldgs.						
Cost to Repacking						
Total Packing Cost		15.87	.018		17.10	
Dunnage 44						
Drayage 45						
Labor Tank Cars						
Labor Car Loads						
Labor LCL						
Switching & Weighing						
Total Shipping Cost						

	Pounds	Bulk Amount	Per Lb.	Packed
Minimum Inventory				
Opening Inventory	43,718	$ 3,349.77	7.51	$
Transferred In		15.72		
Produced	88,829	6,624.[illegible]	7.457	
Total to Account For	132,607	9,989.11	7.533	
Closing Inventory	78,093	5,883.64	7.533	
Disposed of Shipped	54,514	$ 4,106.47	7.533	$
Used C-1443 or -1413	54,514	4,106.47	7.533	

DSW 001425

ADA 000778

EST. BLDGS. $ EQUIP. $ PRODUCT CRUDE AROCLOR # 2565

EST. TOTAL $ SYMBOL SCH 6-1414 MONTH OF [illegible] 1935

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1934 Per Lb.
Per Day							
Per Year							
Rated Capacity							
... 01 (sales)	120		200 535		175,000		
150 AROCLOR			140	.001			
130 DIPHENYL			26 085	.613		.284	.283
131 CHLORINE			124 511	1.239		1.320	1.324
146 AROCLOR 1405			2 225	.172			
147 CRUDE AROCLOR			1 590	.016			
160 AROCLOR			1 377	.013			
130 DIPHENYL			1 977 85	1.961		1.516	2.092
131 CHLORINE			3 724 48	3.247		3.652	3.348
140 AROCLOR - 1416	921		835 17	.831			
107 CRUDE AROCLOR							.039
Total Raw Materials	921		6,110 77	6.074		5.108	6.279
Supervision			93 61	.093			
Labor	7500		232 24	.232		.267	.266
Repairs, Labor			80 70	.050		.134	.134
Material			25 61	.025		.062	.052
Repairs, Labor						.006	.006
Material							
Tools and Supplies			39 22	.039		.039	.039
Filter Cloth 10 Filter Cloth							
Steam			149 77	.149		.117	.117
Water			24 62	.024		.016	.016
Power ...			30 33	.030		.010	.010
... 17 Stocking			2 57	.002		.003	.003
...			3 81	.003		.004	.004
Laboratory	10 88		49 38	.050		.013	.014
Direct Conversion	35 88		736 09	.732		.679	.679
General Plant	2 13		102 05	.102		.000	.114
Employment 26-DIRECT WELFARE							.090
Insurance and Taxes			21 44	.021		.021	.026
Depreciation			161 32	.160		.150	.187
Indirect Conversion	2 13		284 83	[illegible]		.259	.425
Total Conversion	48 51		1,020 92	1.015		.939	1.104
Manufacturing Cost Bulk	10 26		7,131 69	7.093		6.106	7.363

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Drums	10,000	2 72		79 400	50 54	.011
Labor		1 54			5 45	.004
Tank Cars	300	9 67		71,377	140 77	.206
Labor					5 46	.117
Cartons 84 Carboys	1			17		
Labor 84a Labor						
Tank Cars - Fac. Bldg						
Labor 38 7.171						
Labor Storing Bulk Storage					14 20 59	020
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost	10 301	16 97	.941	101,794	107 65	.185
Drayage 44						
Freight 45		3 12			45 54	.032
Labor Tank Cars						
Labor Car Loads				81,375	8 20	.0[illegible]
Labor - LCL	10,301	7 21		31,137	14 18	.046
Switching & Weighing						
Total Shipping Cost	10,301	11 33	.110	71,538	67 87	.046

	THIS MONTH Pounds	Bulk Amount	Per Lb.	YEAR TO DATE Pounds	Packed Amount	Per Lb.
Beginning Inventory						
Opening Inventory	15,794	1,269 64		49,725	3,537 08	7.113
Transferred In						
Produced	120	5,026	1.454	10,301	997 84	9.681
Total to Account For	15,014	1,213 58	8.122	60,026	4,534 92	7.554
Closing Inventory	4,713	319 25	1.774	49,725	3,756 19	[illegible]
Disposed of	10,301	900 33	8.740	10,301	778 73	[illegible]
Shipped 7 days				6,000	276 44	6.774
74 Retail				4,301	303 14	7.042
				10,201	679 58	6.597
Used						
Packing	10 301	900 33	8.748			
Shipping [illegible]						
[illegible]					56 63	
Cost of Sales Adj. 1011 Last Month					720 12	7.554

DSW 001426

ADA 000779

INVST. BLDGS. $ EQUIP. $

INVST. TOTAL $

PRODUCT CRUDE AROCLOR # 3165 **140**

SYMBOL SCH 6-1416 MONTH OF [illegible] 193 5

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb	BUDGET Amount	Per Lb	193 4 Per Lb
Lbs. Per Day							
Cap. Per Year							
Operated % Capacity							
Produced							
Total Raw Materials							
Supervision							
Labor							
Maint. Labor							
" Material							
Maint. Labor							
" Material							
Tools and Supplies							
Screen Cloth / 10 Filter Cloth							
Steam							
Power							
Water / 16 Electrodes or Fuel Oil							
Air / 17 Stocking							
Gas							
Laboratory							
Direct Conversion							
General Plant							
Development							
Insurance and Taxes							
Depreciation							
Indirect Conversion							
Total Conversion							
Manufacturing Cost Bulk							

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb
Barrels						
Labor		92.7				
Kegs Cans						
Labor						
Bags Cartons / 34 Carboys						
Labor / 34a Labor						
Tank Cars Tac. Wag.						
Labor						
Labor Storing						
Maint Storage Equip & Bldgs						
Loss in Repacking						
Total Packing Cost		92.7				
Dunnage 44						
Drayage 44						
Labor Tank Cars						
Labor Car Loads						
Labor LCL						
Switching & Weighing						

	Bulk		Packed	
Total Shipping Cost				
Minimum Inventory				
Opening Inventory				
Transferred In				
Produced	92.7			
Total to Account For	92.7			
Closing Inventory				
Disposed of	92.7			
Shipped				
Used ([illegible]	92.7			

DSW 001427

ADA 000780

WATER_PCB-SD0000045947

INVEST. BLDGS. $ | EQUIP. $ | PRODUCT CRUDE AROCLOR # 4005 | 141
INVEST. TOTAL $ | SYMBOL SCH 6-1420 | MONTH OF 7/ 193 5

	This Month Amount	Per Lb.	Year to Date Amount	Per Lb.	Budget Amount	Per Lb.	193 4 Per Lb.
Cap. Per Day							
Cap. Per Year							
Operated % Capacity							
Production 01			47,324		29,200		
1300 BIPHENYL			71,790	.337		.276	
331 CHLORINE			16,508	1.244		1.354	
1301 DISTILLED HIGH BOILER			7,800	.1[illegible]		.168	
1300 BIPHENYL			804.86	.7643		2.263	
331 CHLORINE			1,934.38	[illegible]		3.683	
1301 DISTILLED HIGH BOILER			175.04	[illegible]		.897	
Total Raw Materials			2,9[illegible]	.519		6.843	
01 Supervision			44.17	.640		.200	
02 Labor			33.38	.147		.060	
04 Maint. Labor			31.16	.043		.060	
05 " Material			6.25	.013			
06 Maint. Labor							
07 " Material			25.30	.151		.050	
08 Tools and Supplies							
09 Screen Cloth 10 Filter Cloth			70.05	.147		.150	
11 Steam			12.12	.022		.0[illegible]	
12 Power			5.42	.011		.010	
13 Water 16 Electrodes or Fuel Oil							
14 Air 17 Stocking			3.07	.006		.010	
15 Gas			4.61	.009		.005	
18 Laboratory							
Direct Conversion			2[illegible]	.5[illegible]		.6[illegible]	
21 General Plant			4[illegible]	.041		.07[illegible]	
22 Development						.0[illegible]	
23 Insurance and Taxes			1[illegible]	.0[illegible]		.150	
24 Depreciation			[illegible]	[illegible]		.254	
Indirect Conversion			1[illegible]	.36[illegible]		.969	
Total Conversion			3[illegible]	[illegible]			
Manufacturing Cost Bulk			3,119.55	1.394		7.717	

PACKING AND SHIPPING COST	This Month Pounds	Amount	Per Lb.	Year to Date Pounds	Amount	Per Lb.
31 Barrels						
31a Labor					1,175	.026
32 Kegs Cans						
32a Labor						
33 Bags Cartons 34 Cartons						
33a Labor 34a Labor						
35 Tank Cars Fer. Slag *Bulk Storing*						
35a Labor					11.51	.0[illegible]2
36 Labor Storing						
38 Maint. Storage Equip. & Bldgs.						
50 Loss in Repacking					30.7[illegible]	
Total Packing Cost						
40 Dunnage 44						
42 Drayage 45						
41 Labor Tank Cars						
43 Labor Car Loads						
45 Labor LCL						
47 Switching & Weighing						
Total Shipping Cost						

	Bulk		Packed	
Minimum Inventory				
Opening Inventory				
Transferred In				
Produced				
Total to Account For				
Closing Inventory				
Disposed of				
Shipped				
Used				

DSW 001428

ADA 000781

INVST. BLDGS. $ EQUIP. $ PRODUCT [illegible]

INVST. TOTAL $ SYMBOL SCK 6-1423 MONTH OF [illegible] 19[illegible]

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb	BUDGET Amount	BUDGET Per Lb	19[illegible] Per Lb.
Per Bal							
Per Year	—		—				
[illegible] Capacity	—		—				
[illegible]					2,380		
LABORATORY SAMPLES						.417	.426
DISTILLED HIGH BOILER						.278	.279
[illegible]							
7301 DISTILLED HIGH BOILER	$		$			3.284	3.020
301 CHLORINE						3.515	3.34[illegible]
LABORATORY SAMPLES							
Total Raw Materials						6.799	6.362
Supervision							.159
Labor						.3[illegible]	.60[illegible]
Maint. Labor						.014	.045
" Material						.024	.040
Maint. Labor						.004	.003
" Material							
Tools and Supplies						.021	.030
Screen Cloth 10 Filter Cloth							
Steam						.102	.110
Power						.0[illegible]6	.0[illegible]
Water 16 Electrodes or Fuel Oil						.037	.05[illegible]
Air 17 Stocking						.007	.07[illegible]
Gas						.0[illegible]	.002
Laboratory						.127	.226
Direct Conversion						.745	1.365
General Plant						.080	.201
Development 26-DIRECT WELFARE							
Insurance and Taxes						.021	.010
Depreciation						.158	.1[illegible]
Indirect Conversion						[illegible]	.[illegible]
Total Conversion						1.[illegible]4	1.[illegible]
Manufacturing Cost Bulk						7.[illegible]	[illegible].16[illegible]

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb
Barrels						
Labor						
Kegs Cans						
Labor						
Bags Cartons 84 Carboys	10			11		
Labor 84a Labor						
Tank Cars - For. Stng						
Labor 31 & 38 [illegible]						
Labor Storing						
Maint. Storage Equip. & Bldgs						
Loss In Repacking						
Total Packing Cost	10			11		
Dunnage 44						
Drayage 45						
Labor Tank Cars						
Labor Car Loads						
Labor LCL	10	.01		10	.01	
Switching & Weighing						
Total Shipping Cost	10	$ .01	.010	10	$ .01	.010

	Bulk Pounds	Bulk Amount	Bulk Per Lb.	Packed Pounds	Packed Amount	Packed Per Lb
Minimum Inventory						
Opening Inventory	699	$ 71[illegible]	10.25[illegible]		$	
Transferred In						
Produced				10	1.03	10.3[illegible]
Total to Account For	699	7170	10.257	10	1.03	1[illegible]
Closing Inventory	689	70[illegible]	10.257			
Disposed of	10	103	10.257	10	103	10.3
Shipped (SD-105)		$		10	$ 1.0	10.[illegible]
Used						
Packing	10	103	10.257			
[illegible]					.01	
Cost of Sales Adj. 3811 Last Month / [illegible] This Month					.04	
		$ 103	10.257	10	$ 103	10.[illegible]

DSW 001429

ADA 000782

WATER_PCB-SD0000045949

INVEST. BLDGS. $ 33,074.82 EQUIP. $ 28,323.05 PRODUCT DISTILLED AROCLOR TOTAL

INVEST. TOTAL $ 61,397.37 SYMBOL SCH.G-143 MONTH OF MAY 195 5

	This Month Amount		This Month Per Lb.	Year to Date Amount		Year to Date Per Lb.	Budget Amount	Budget Per Lb.	195 Per Lb
Per Day									
Per Year									
Operated % Capacity									
Production	103,541			520,951					
Crude Aroclor	112,446			589,726					
1520 Research Prods.									
Aroclor Line 544	3,300			17,156					
Toluol 913	85			784					
Distilled Aroclor				6,821					
Distilled Aroclor	$			$ 7,168	29				
Crude Aroclors	7982	44		44,032	43				
1520 Misc. Research Prods.									
544 Aroclor Line	76	87		87	50				
913 Toluol	6	76		20	91				
Total Raw Materials	8,007	51		44,368	93				
Supervision	77	93		380	83				
Labor	418	86		2,271	36				
Maint. Labor	61	26		175	25				
" Material	50	57		637	37				
Maint. Labor				28	55				
" Material									
Tools and Supplies	48	63		239	96				
Screen Cloth / 10 Filter Cloth									
Steam	79	28		379	68				
Power	60	00		482	00				
Water / 66 Electrodes or Fuel Oil	36	42		180	58				
Air / 17 Blocking									
Gas	107	81		637	68				
Laboratory	15	17		252	84				
Direct Conversion	950	93		6,377	55				
General Plant	322	58		1,775	05				
Development PG-DIRECT WELFARE									
Insurance and Taxes	91	74		341	30				
Depreciation	748	42		2,782	22				
Indirect Conversion	1,162	74		4,898	62				
Total Conversion	2,013	17		10,776	23				
Manufacturing Cost Bulk	10,022	68		55,145	17				

Packing and Shipping Cost	This Month Pounds	This Month Amount		This Month Per Lb.	Year to Date Pounds	Year to Date Amount		Per Lb
Barrels	11				1,700			
Labor		1	40			19	35	
Kegs—Cans	57,147	481	34		383,929	2,322	87	
Labor						56	24	
Bags Cartons / 04 Carboys	42,157	63	97		161,975	203	26	
Labor / 04a Labor		27	72			141	35	
Tank Cars—Tot. Bing								
Labor 24 ...		47	75			57	69	
Labor Storing Bulk Storage		13	77			71	92	
Maint. Storage Equip. & Bldgs.								
Loss in Repacking								
Total Packing Cost	100,189	650	71		547,104	2,882	77	
Dunnage 44		11	51			58	22	
Drayage 45		9	26			44	76	
Labor—Tank Cars								
Labor Car Loads	122,150	31	84		330,675	81	64	
Labor LCL	27,189	24	02		141,919	225	93	
Switching & Weighing						1	85	
Total Shipping Cost	149,939	$ 77	11		472,594	$ 412	40	
		Bulk				Packed		
Minimum Inventory								
Opening Inventory		$			347,395	$ 40,377	69	
Transferred in		61	18					
Produced	103,541	10,022	68		99,981	10,359	37	
Total to Account For	103,541	10,084	36		447,376	50,737	06	
Closing Inventory	3,560	314	06		296,983	34,848	10	
Disposed of	99,981	9,770	30		150,393	15,888	96	
Shipped		$			147,377	$ 14,317	44	
✓ JC WMN					2,500	276	05	
Used 6-1413-01-1293					538	64	19	
✓ 6-1460-01-301					298	32	06	
Packing	99,981	9,770	30					
Samples 141-25					34	4	72	
...						1,255	49	

DSW 001430

ADA 000783

INVEST. BLDGS. $ EQUIP. $

INVEST. TOTAL $

PRODUCT DISTILLED AROCLOR # 1610 144

SYMBOL SCH 6-1431 MONTH OF May 1935

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1934 Per Lb.
# Per Day							
# Per Year							
% of Capacity							
Production							
1401 CRUDE AROCLOR # 1110							
MONO CHLORODIPHENYL INT							.582
ORTHO CHLORODIPHENYL							.418
PARACHLOR DIPHENYL							.020
1500 MONO CHLORODIPHENYL-INT	$		$				$0.935
1500 ORTHO CHLORODIPHENYL							7.863
1401 AROCLOR # 1110							
1500 PARACHLOR DIPHENYL							.365
Total Raw Materials							$9.163
Supervision							.784
Labor							4.235
Maint., Labor							.771
" Material							.131
Maint., Labor							
" Material							
Tools and Supplies							.119
Screen Cloth 10 Filter Cloth							
Steam							
Power							
Water 16 Electrodes or Fuel Oil							
Air 17 Stacking							
Gas							
Laboratory							.013
Direct Conversion							6.053
General Plant							1.497
Development							
Insurance and Taxes							.359
Depreciation							2.719
Indirect Conversion							4.575
Total Conversion							10.628
Manufacturing Cost Bulk							20.791

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels						
Labor						
Kegs Cans					142	
Labor						
Kegs Cartons 34 Carboys				2		
Labor 34a Labor						
Tank Cars For. Stg.						
Labor 38 MATLS USED IN STORING						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost					182	
Dunnage 44						
Drayage 45						
Labor Tank Cars						
Labor Car Loads						
Labor LCL	1			57	10	.192
Switching & Weighing						
Total Shipping Cost	1			57	10	.192

	Bulk		Packed	
Minimum Inventory				
Opening Inventory	$	87	$ 3982	34.273
Transferred In				
Produced				
Total to Account For		87	3982	34.273
Closing Inventory		86	3948	34.273
Disposed of		1	34	34.273
Shipped 7 Days (Detail)	$		$ 44	
Used				
Pure flo			34	

DSW 001431

ADA 000784

WATER_PCB-SD0000045951

1. BLDGS. $ EQUIP. $

1. TOTAL $

PRODUCT DISTILLED AROCLOR # 1848 **145**

SYMBOL SCH 5-1432 MONTH OF [illegible] 193 5

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	BUDGET Per Lb.	193 4 Per Lb.
Days							
Test							
% Capacity							
Total Raw Materials							
Supervision							
Labor							
Maint. Labor							
" Material							
Maint. Labor							
" Material							
Tools and Supplies							
Screen Cloth 10 Filter Cloth							
Steam							
Power							
Water 15 Electrodes or Fuel Oil							
Air 17 Stacking							
Gas							
Laboratory							
Direct Conversion							
General Plant							
Development							
Insurance and Taxes							
Depreciation							
Indirect Conversion							
Total Conversion							
Manufacturing Cost Bulk							

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb.
31 Barrels						
31a Labor						
32 Kegs Cans						
32a Labor					1 35	
33 Kegs Cartons 34 Carboys						
33a Labor 34a Labor						
35 Tank Cars Fac. Stg.						
35a Labor						
36 Labor Storing						
37 Maint. Storage Equip. & Bldgs.						
38 Loss in Repacking						
Total Packing Cost					1 35	
39 Dunnage 40						
40 Drayage 45						
41 Labor Tank Cars						
42 Labor Car Loads						
43 Labor LCL						
47 Switching & Weighing						
Total Shipping Cost						

	Bulk Pounds	Bulk Amount		Packed Pounds	Packed Amount	Per Lb.
Minimum Inventory						
Opening Inventory		$		1,794	$ 368 93	0.565
Transferred In						
Produced						
Total to Account For				1,794	368 93	[illegible]
Closing Inventory				1,794	368 93	[illegible]
Disposed of						
Shipped		$			$	
Used						

DSW 001432

ADA 000785

WATER_PCB-SD0000045952

[illegible] BLDGS. $ EQUIP. $

[illegible] TOTAL $

PRODUCT DISTILLED AROCLOR # 1242 146

SYMBOL SCH 6-1433 MONTH OF / 1935

	THIS MONTH Amount	THIS MONTH Per Lb	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	Per Lb	1934 Per Lb.
[illegible] Capacity					30,000		
.. D1							
4.3 CRUDE AROCLOR # 1142						1.042	1.04[illegible]
544 AROCLOR LIME						.024	[illegible]
540 LIME HYDRATE							
1403 CRUDE AROCLOR # 1142						8.762	9.374
544 AROCLOR LIME						.015	.01[illegible]
540 LIME HYDRATE							
[illegible]						8.777	9.3[illegible]
[illegible]						.622	.6[illegible]
[illegible]						.722	.7[illegible]
[illegible] Labor						.700	.94[illegible]
[illegible] Material						.460	.634
[illegible] Labor							
Material							
[illegible] Supplies						.305	.3
[illegible] 10 Filter Cloth						.000	.000
[illegible]						.205	.2[illegible]
[illegible] 1. [illegible]						.034	.03[illegible]
[illegible] 17 Stocking							
[illegible]						.100	.10[illegible]
[illegible]						.001	.0[illegible]
[illegible]						3.457	3.6[illegible]
[illegible]						.200	.423
[illegible]							.1[illegible]
[illegible] and Taxes						.075	[illegible]
[illegible]						.620	.39[illegible]
General Conversion						.933	1.072
Total Conversion						4.390	4.6[illegible]
22 Manufacturing Cost Bulk						13.167	14.346

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb
[illegible]						
[illegible] Labor						
31 Kegs Cans						
[illegible] Labor						
33 Kegs Cartons 34 Carboys						
[illegible] Labor 34a Labor						
37 Tank Cars Tot Slag						
[illegible] Labor						
38 Labor Storing						
39 Maint Storage Equip. & Bldgs						
[illegible] Loss in Repacking						
Total Packing Cost						
35 Dunnage						
37 Drayage						
4[illegible] Labor Tank Cars						
41 Labor Car Loads						
41 Labor LCL						
41 Switching & Weighing						
Total Shipping Cost						

	Bulk		Packed	
Minimum Inventory				
Opening Inventory				
Transferred In				
Produced				
Total to Account For				
Closing Inventory				
Disposed of				
Shipped				
Used				

DSW 001433

ADA 000786

WATER_PCB-SD0000045953

INST. BLDGS. $ EQUIP. $

INST. TOTAL $

PRODUCT DISTILLED AROCLOR # 1248 SYMBOL SCH 6-1435 MONTH OF [illegible] 1935

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb.	Budget Amount	Budget Per Lb.	1934 Per Lb.
Pounds Produced 01 [illegible]	175		19581		20,000		
1405 Crude Aroclor # 1148			20.333	1.04		1.003	1.061
Aroclor Line			295	.015		.015	.014
1407 Aroclor # 1140			1760.03	9.016		9.055	9.[illegible]
544 Aroclor Line			196	[illegible]		.013	.010
Total Raw Materials			1761.78	[illegible]		9.078	9.[illegible]
Supervision			30.00	.154		.782	.61
Labor			88.41	.453		.696	.710
Repairs Labor			10.90	.056		.660	.61[illegible]
Repairs Material			1.70	.009		.600	.618
Maint. Labor							
Maint. Material							
Tools and Supplies			8.33	.043		.347	.201
Filter Cloth (10 Filter Cloth)							
Steam						.069	.121
Power			22.00	.113		.200	.179
Water (16 Circulation of water)			1.74	.009		.048	.046
Air (17 Stacking)							
Gas			16.55	.085		.136	.124
Laboratory			11.91	.059		.131	.093
Direct Conversion			191.78	.979		3.869	3.402
General Plant			39.39	.201		.200	.304
20 Direct Welfare							.116
Insurance and Taxes			8.65	.044		.075	.059
Depreciation			72.41	.371		.628	.490
Indirect Conversion			120.45	.617		.903	.969
Total Conversion			312.23	1.598		4.766	4.971
02 Manufacturing Cost Bulk			2073.11	10.619		13.634	13.723

Packing and Shipping Cost	This Month Pounds	This Month Amount	This Month Per Lb.	Year to Date Pounds	Year to Date Amount	Year to Date Per Lb.
Barrels						
Labor						
Kegs Cans	17	1.71		19.667	152.13	.776
Labor					2.33	.012
Bags Cartons / 84 Carboys	17			22		
Labor / 84a Labor						
Tank Cars Fos. Slag						
Labor						
Labor Storing					.71	.004
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost		1.71		19.649	155.33	.791
Dunnage 44						
Drayage 45		1.33			5.71	.029
Labor Tank Cars						
Labor Car Loads						
Labor LCL	1527	1.35		12.224	21.38	.168
Switching & Weighing						
Inter Ship of Equip					.81	
Total Shipping Cost	1.527	2.68	.176	12.749	28.80	.229

	Bulk				Packed	
Minimum Inventory						
Opening Inventory				16,838	1,909.58	11.339
Transferred In						
Produced				122	13.41	
Total to Account For				16,960	1,908.74	11.413
Closing Inventory				15,183	1,734.36	11.42
Disposed of				1,577	174.32	11.4[illegible]
Shipped Kegs				1,000	8[illegible]	
LCL Pkg				523	58.6[illegible]	
				1,523	139.46	9.157
Used						
Sample [illegible] = 141-2.5				4	.46	11.413
[illegible] Cost of Ship						
					11.42	
					25.27	11.4[illegible]

DSW 001434

ADA 000787

WATER_PCB-SD0000045954

INST. BLDGS. $ EQUIP. $ PRODUCT DISTILLED AROCLOR # 1250 148
INST. TOTAL $ SYMBOL BCH 6-1436 MONTH OF 7/ 195

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	BUDGET Per Lb.	Per Lb.
Lbs. Per Day							
Lbs. Per Year							
Percent % Capacity							
1406 CRUDE AROCLOR # 1150					8,000	1.002	
AROCLOR LIME						.015	
1406 AROCLOR # 1150						8.118	
544 AROCLOR LIME						.011	
Total Raw Materials						8.120	
Supervision						.200	
Labor						.618	
Misc. Labor						.017	
Material							
Maint. Labor							
Material							
Tools and Supplies						.108	
Filter Cloth — 10 Filter Cloth							
Steam						.146	
Power						.082	
Water — 16 Electrodes or Fuel Oil						.009	
Air — 17 Stocking							
Gas						.080	
Laboratory						.482	
Direct Conversion						1.757	
General Plant						.282	
Development							
Insurance and Taxes						.075	
Depreciation						.620	
Indirect Conversion						.985	
Total Conversion						2.742	
Manufacturing Cost Bulk						10.871	

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount		Per Lb.
Barrels							
Labor							
Kegs Cans							
Labor							
Bags Cartons — 34 Carboys				5			
Labor — 34a Labor							
Tank Cars Fco. Bldg.							
Labor							
Labor Storing							
Maint. Storage Equip. & Bldgs.							
Loss in Repacking							
Total Packing Cost							
Dunnage 44							
Drayage 45							
Labor Tank Cars							
Labor Car Loads							
Labor LCL				5		01	.200
Switching & Weighing							
Total Shipping Cost				5		01	.051

	Bulk				Packed		
Minimum Inventory							
Opening Inventory				2,927	373	68	12.766
Transferred In							
Produced							
Total to Account For				2,927	373	68	12.766
Closing Inventory				2,927	373	68	12.766
Disposed of							
Shipped 7 Bags							
Used							

DSW 001435

ADA 000788

WATER_PCB-SD0000045955

EST. BLDGS. $ EQUIP. $ PRODUCT DISTILLED AROCLOR # 1254

EST. TOTAL $ SYMBOL BCH 6-1437 MONTH OF [illegible] 1935

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb.	Budget Amount	Budget Per Lb.	1934 Per Lb.
Per Day							
Per Year							
Percent of Capacity							
Acc. 01	55,789		100,397		670,149		
1407 CRUDE AROCLOR # 1154	57,908	1.038	[illegible]	1.040		1.035	1.034
1437 REDISTILLED AROCLOR # 1254							
AROCLOR LIME 544	575	.010	2,764	.011		.014	.014
LIME HYDRATE 540							
1407 AROCLOR # 1154	3,879 77	6.955	15,762 49	7.8[illegible]		8.291	8.813
1437 AROCLOR # 1254							
544 AROCLOR LIME	7 73	.005	[illegible]	[illegible]		.009	.009
540 LIME HYDRATE							
Total Raw Materials	3,887 95	6.960	15,773 77	7.311		8.300	8.822
Supervision	54 72	.981	188 32	.094		.338	.334
Labor	221 00	.396	720 55	.384		.464	.453
Maint. Labor	17 78	.032	125 15	.053		.180	.220
" Material	4 38	.008	113 24	.057		.130	.176
Maint. Labor			5 92	.003		.002	.002
" Material							
Tools and Supplies	12 37	.022	71 77	.036		.166	.165
Screen Cloth 10 Filter Cloth							
Steam	79 78	.143	131 98	.066		.096	.115
Power	40 00	.072	185 09	.092		.090	.090
Water 45 [illegible]	18 71	.033	50 56	.025		.021	.022
Air 17 Stocking							
Oil	58 67	.105	242 62	.129		.108	.104
Laboratory	3 11	.005	140 65	.070		.096	.106
Direct Conversion	494 52	.886	2,080 81	1.038		1.691	1.796
General Plant	103 49	.191	322 84	.161		.200	.216
Departmental 26 DIRECT WELFARE							.039
Insurance and Taxes	41 50	.078	111 13	.055		.075	.100
Depreciation	350 53	.628	850 53	.424		.620	1.415
Indirect Conversion	496 12	.894	1,345 55	.671		.903	1.548
Total Conversion	992 24	1.780	3,445 82	1.719		2.594	3.744
Manufacturing Cost Bulk	4,876 14	8.740	19,219 57	9.573		10.804	12.566

PACKING AND SHIPPING COST	This Month Pounds	This Month Amount	This Month Per Lb.	Year to Date Pounds	Year to Date Amount	Year to Date Per Lb.
Barrels						
Labor						
Kegs-Cans	52,441	462 37		196,811	1,719 45	.0[illegible]
Labor					14 50	[illegible]
Bags Cartons 84 Carboys	88			166		
Labor 84a Labor						
Tank Cars - Fee. Bldg						
Labor 387 [illegible]		25 61			29 11	.015
Labor Storing		1 67			17 18	.007
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost	52,369	487 20	.934	196,977	1,781 88	[illegible]
Dunnage 44		05			92	
Drayage 45		5 66			72 07	.037
Labor - Tank Cars						
Labor - Car Loads	80,750	7 88		120,815	15 38	.013
Labor LCL	15,760	13 92		76,467	122 07	.160
Switching & Weighing						
44 [illegible]					17	
Total Shipping Cost	96,010	27 11	.028	196,182	160 66	[illegible]

	This Month Pounds	Bulk Amount	Bulk Per Lb.	Year to Date Pounds	Packed Amount	Per Lb.
Minimum Inventory						
Opening Inventory				75,645	8,134 61	10.754
Transferred in BULK STORING [illegible]		26 68				
Produced	55,789	4,876 14	8.740	52,789	5,057 53	9.6[illegible]
Total to Account For	55,789	4,902 82	8.788	127,434	13,172 54	10.3[illegible]
Closing Inventory	3,506	307 59	8.788	31,422	3,211 44	10.31[illegible]
Disposed of	52,283	4,595 23	8.788	96,012	9,961 [illegible]	10.3[illegible]
Shipped 7 Days				12,002	1,339 92	
Total Days				83,970	8,141 83	
				95,972	9,479 65	9.877
Used						
Packing	52,289	4,595 23	8.788			
[illegible]				40	4 12	10.[illegible]
[illegible] Cost Last Month					878 46	
				[illegible]	9,900 35	10.31[illegible]

OSW 001436

ADA 000789

WATER_PCB-SD0000045956

VEST. BLDGS. $	EQUIP. $	PRODUCT DISTILLED AROCLOR # 1260	150
VEST. TOTAL $		SYMBOL SCH 5-1433 MONTH OF /	1935

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	Per Lb.
AROCLOR # 1160 AROCLOR LINE							3.033 .022
LIME HYDRATE							
AROCLOR # 1160 AROCLOR LINE							9.429 .0.2
Total Raw Materials							9.43
Supervision							.542
Labor							.660
Labor							.400
Material							.061
Labor							.001
Material							
Tools and Supplies							.100
Filter Cloth / 10 Filter Cloth							
Steam							.016
Power							.034
Water / 16 Electrodes or Fuel Oil							
Air / 17 Stocking							.126
Gas							.097
Laboratory							
Direct Conversion							2.151
General Plant							.327
Development							
Insurance and Taxes							.383
Depreciation							2.7[illegible]
Indirect Conversion							3.446
Total Conversion							5.597
Manufacturing Cost Bulk							15.035

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels						
Labor						
Bags Cans		[illegible]		[illegible]	[illegible]	.5
Labor						
Bags Cartons / 34 Carboys				[illegible]		
Labor / 34a Labor						
Tank Cars Tote Bins						
Labor [illegible]	[illegible]					
Labor Storing						
Maint. Storage Equip. & Bldgs						
Supp. to Repacking						
Total Packing Cost		[illegible]			[illegible]	[illegible]
Dunnage						
Drayage						
Labor Tank Cars						
Labor Car Loads						
Labor LCL	[illegible]	[illegible]		[illegible]	10	.093
Switching & Weighing						
Total Shipping Cost	[illegible]	[illegible]	[illegible]	[illegible]	10	

	Bulk		Packed	
Minimum Inventory		[illegible]	10,923	[illegible]
Opening Inventory				
Transferred In				
Produced		[illegible]	[illegible]	[illegible]
Total to Account For		[illegible]	[illegible]	[illegible]
Closing Inventory		[illegible]	[illegible]	[illegible]
Disposed of				
Shipped			[illegible]	[illegible]
Used				

DSW 001437

ADA 000790

WATER_PCB-SD0000045957

BLDGS. $ EQUIP. $ PRODUCT DISTILLED AROCLOR # 1262 151

TOTAL $ SYMBOL SCH 6-1439 MONTH OF [illegible] 1955

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb.	Budget Amount	Budget Per Lb.	1954 Per Lb.
Capacity							
Of			[illegible]		20,500		
1409 CRUDE AROCLOR # 1162			[illegible]			1.052	1.042
AROCLOR LIME			[illegible]	[illegible]		.010	.007
TOLUOL	$		$ [illegible]	[illegible]			.005
1409 AROCLOR # 1162			[illegible]	[illegible]		8.563	9.300
544 AROCLOR LIME						.008	.006
613 TOLUOL	[illegible]						.024
Raw Materials	[illegible]		[illegible]			8.591	9.337
			[illegible]	[illegible]		.584	.500
				[illegible]		.540	.476
Labor				[illegible]		.560	.567
Material			[illegible]	[illegible]		.400	.477
Labor							
Material							
Supplies				[illegible]		.321	.278
Cloth — 10 Filter Cloth							
						.012	.122
			[illegible]	[illegible]		.215	.185
[illegible]			[illegible]			.035	.036
17 Stacking			[illegible]	[illegible]		.168	.146
	[illegible]		[illegible]			.070	.060
Conversion	[illegible]			[illegible]		2.949	2.645
Plant				[illegible]		.200	.275
Equipment							.000
Insurance and Taxes			[illegible]	[illegible]		.075	.130
Depreciation						.626	1.016
Conversion	[illegible]		[illegible]	[illegible]		.903	1.509
Total Conversion			[illegible]	[illegible]		3.852	4.358
Manufacturing Cost Bulk			[illegible]	[illegible]		12.443	13.697

PACKING AND SHIPPING COST	This Month Pounds	This Month Amount	This Month Per Lb.	Year to Date Pounds	Year to Date Amount	Year to Date Per Lb.
Barrels						
Labor						
Kegs - Cans		[illegible]		[illegible]	[illegible]	
Labor						
Bags - Cartons — 94 Carboys	[illegible]			[illegible]		
Labor — 94a Labor						
Tank Cars - Fdt. Stg.						
Labor		[illegible]			[illegible]	
Labor Storing						
Metal Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost		[illegible]		[illegible]	[illegible]	[illegible]
Dunnage						
Drayage		[illegible]			[illegible]	
Labor - Tank Cars						
Labor - Car Loads		[illegible]		[illegible]	[illegible]	
Labor - LCL		[illegible]		[illegible]		[illegible]
Switching & Weighing						
Total Shipping Cost	[illegible]	[illegible]		[illegible]	[illegible]	

	Bulk			Packed		
Minimum Inventory						
Opening Inventory	$			[illegible]	[illegible]	
Transferred In						
Produced					[illegible]	
Total to Account For				[illegible]	[illegible]	
Closing Inventory					[illegible]	
Disposed of				[illegible]		
Shipped [illegible]	$			[illegible]	[illegible]	
[illegible]				[illegible]	[illegible]	
[illegible]				[illegible]	[illegible] 9.921	
Used						
[illegible]				[illegible]	[illegible]	

DSW 001438

[illegible]

ADA 000791

WATER_PCB-SD0000045958

EST. BLDGS. $ EQUIP. $ PRODUCT DISTILLED AROCLOR # 1264

EST. TOTAL $ SYMBOL SCH 6-1410 MONTH OF 2/... 1953

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1954 Per Lb.
Per Day							
Per Year							
Rated Capacity							
Per Cent							
Total Raw Materials							
Supervision							
Labor							
Maint. Labor							
" Material							
Maint. Labor							
" Material							
Tools and Supplies							
Screen Cloth / 10 Filter Cloth							
Steam							
Power							
Water / 16 Electrodes or Fuel Oil							
Air / 17 Storking							
Gas							
Laboratory							
Direct Conversion							
General Plant							
Development							
Insurance and Taxes							
Depreciation							
Indirect Conversion							
Total Conversion							
Manufacturing Cost Bulk							

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels						
Labor						
Kegs Cans					120	
Labor						
Bags Cartons / 34 Carboys				8		
Labor / 34a Labor						
Tank Cars For. Ship						
Labor						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost					120	
Dunnage 44						
Drayage 45						
Labor Tank Cars						
Labor Car Loads						
Labor LCL				70	07	.100
Switching & Weighing						
Total Shipping Cost				70	07	.100
	Bulk				Packed	
Minimum Inventory						
Opening Inventory				93	2411	5.923
Transferred In						
Produced						
Total to Account For				93	2411	5.923
Closing Inventory				93	2411	5.923
Disposed of						
Shipped 7 Arago					21	
Used						

DSW 001439

ADA 000792

INV. BLDGS. $ EQUIP. $

INV. TOTAL $

PRODUCT DISTILLED AROCLOR # 1268 158

SYMBOL SCH 6-1442 MONTH OF May 1935

	THIS MONTH Amount	Per Lb.	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb.	1934 Per Lb.
[illegible]	—		—				
[illegible] Capacity	—		—		20,000		
1412 CRUDE AROCLOR # 1168						1.032	1.026
AROCLOR LINE						.013	.017
1412 AROCLOR # 1168						7.979	8.480
1442 AROCLOR # 1268 544 AROCLOR LINE						.006	.006
Tot. Raw Materials						7.905	8.492
Supervision						.340	.312
Labor			480			.807	.816
Maint. Labor						.149	.122
Maint. Material						.094	.163
Repair Labor							
Repair Material							
Tools and Supplies						.403	.309
Filter Cloth — 10 Filter Cloth						.475	.733
Steam						.039	.094
Power						.010	.030
Water — 16 Electrodes or Fuel Oil							
17 Stocking						.135	.120
[illegible]						.072	.043
Intraplant			490				
Direct Conversion			950			2.524	2.750
General Plant			143			.200	.348
Development							
Insurance and Taxes						.075	.174
Depreciation						.620	1.320
Indirect Conversion			143			.903	1.842
Total Conversion			1093			3.427	4.592
Manufacturing Cost Bulk			1093			11.412	13.004

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Barrels		1600		1	1395	
Labor	750	171		750	365	2.433
Bags Cans					4	
Labor						
Bags Cartons 84 Carboys	15			20		
Labor 84a Labor						
Tank Cars Tec. Stag						
Labor 38 [illegible] for Storing						
Labor Storing						
Maint Storage Equip. & Bldgs						
Loss in Repacking						
Total Packing Cost		1771	—	—	3764	
Dunnage 44						
Drayage 45		100			275	.036
Labor Tank Cars						
Labor Car Loads						
Labor LCL	2,815	248		7,547	1022	.137
Batching & Weighing						
Total Shipping Cost	2,815	348	.124	7,547	1308	.173
		Bulk			Packed	
Minimum Inventory				7,056	93768	13.299
Opening Inventory						
Transferred In					1721	
Produced				7,056	95489	13.533
Total to Account For				4,241	56344	13.533
Closing Inventory				2,815	38065	13.522
Disposed of						
Shipped 7 Bags 2 [illegible] Week 6				2,811	37416 37526	13.351
Used						
Samples — [illegible]				4	54	13.535
[illegible]					371 413	

DSW 001440

ADA 000793

WATER_PCB-SD0000045960

EST. BLDGS. $ [illegible] EQUIP. $ [illegible]

EST. TOTAL $ 13,012.1[illegible]

PRODUCT DISTILLED AROCLOR # 1269

SYMBOL SCH 6-1443

MONTH OF [illegible] 1955

154

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb.	Budget Amount	Budget Per Lb.	1954 Per Lb.
Per Day / Per Year							
Capacity							
01	[illegible]		[illegible]		500,000		
1413 CRUDE AROCLOR # 1169	[illegible]	[illegible]	[illegible]	[illegible]		1.140	1.139
544 AROCLOR LIME	[illegible]	.027	[illegible]			.053	.053
540 LIME HYDRATE							
1401 CRUDE AROCLOR # 1119							.00[illegible]
431 AROCLOR # 1119							.010
1413 AROCLOR # 1169	[illegible]	8.562	[illegible]			9.856	8.775
544 AROCLOR LIME	[illegible]	.021				.030	.030
540 LIME HYDRATE							
Total Raw Materials	[illegible]	8.591	[illegible]			9.889	8.815
Supervision	[illegible]	.061	[illegible]			.420	.419
[illegible]	[illegible]	.412	[illegible]			.606	.606
Maint. Labor	[illegible]	.091	[illegible]			.211	.210
Material	[illegible]	.096	[illegible]			.267	.277
Repl. Labor							
Material							
Tools and Supplies	[illegible]	.076	[illegible]			.045	.040
Filter Cloth — 10 Filter Cloth							
Steam							
Power	[illegible]	.042	[illegible]			.058	.058
Water	[illegible]	.038	[illegible]			.024	.024
17 Stocking						.005	.005
[illegible]	[illegible]	.102	[illegible]			.118	.118
Laboratory	[illegible]	.044	[illegible]			.025	.026
Direct Conversion	[illegible]	.910	[illegible]			1.781	1.781
General Plant	[illegible]	.042	[illegible]			.210	.243
26 DIRECT WELFARE							.004
Insurance and Taxes	[illegible]	.163	[illegible]			.075	.06[illegible]
Depreciation	[illegible]	.520				.626	.403
Indirect Conversion	[illegible]	[illegible]	[illegible]			.913	.651
Total Conversion	[illegible]	[illegible]				2.694	2.032
Manufacturing Cost Bulk	[illegible]	10.106	[illegible]			12.583	1.467

PACKING AND SHIPPING COST

	This Month Pounds	This Month Amount	Per Lb.	Year to Date Pounds	Year to Date Amount	Per Lb.
Barrels						
Labor						
Kegs- Cans				[illegible]	[illegible]	
Labor						
Bags- Cartons — 34 Carboys	[illegible]	[illegible]		[illegible]	[illegible]	
Labor — 34a Labor		[illegible]			[illegible]	
Tank Cars—Fcc. Slag						
Labor	[illegible]	[illegible]			[illegible]	[illegible]
Labor Storing		[illegible]				
Maint. Storage Equip. & Bldgs.						
Loss in Reworking						
Total Packing Cost	[illegible]	[illegible]	.264	[illegible]	[illegible]	
Dunnage		[illegible]			[illegible]	[illegible]
Drayage						
Labor--Tank Cars						
Labor- Car Loads	[illegible]	[illegible]		[illegible]	[illegible]	
Labor--LCL						
Switching & Weighing						
Total Shipping Cost	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Minimum Inventory		Bulk			Packed	
Opening Inventory				6,553	[illegible]	[illegible]
Transferred In	[illegible]					
Produced	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total to Account For	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Closing Inventory	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Disposed of	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Shipped					[illegible]	
Used					[illegible]	

DSW 001441

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WATER_PCB-SD0000045961

INVEST. BLDGS. $ EQUIP. $

INVEST. TOTAL $

PRODUCT DISTILLED AROCLOR # 4465
SYMBOL SCH 6-1450 MONTH OF May 1955

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	BUDGET Per Lb.	1954 Per Lb.
Cap. Per Day							
Cap. Per Year							
Operated % Capacity							
Production 01			69,487		42,000		
1453 CRUDE AROCLOR 5460			6,837	.098			
1420 CRUDE AROCLOR # 4065			59,855	1.228		1.248	1.230
1411 CRUDE AROCLOR # 1165			74,558	1.09			
544 AROCLOR LIME			878	.013		.008	.000
01 1453 CRUDE AROCLOR 5460			$ 1168 09	1.681			
01 1411 AROCLOR # 1165			1,081 84	1.557			
01 1420 AROCLOR # 4065			3,465 04	4.986		9.576	8.314
01 544 AROCLOR LIME			4 25	.007			.005
01							
Total Raw Materials			5,719 22	8.231		9.576	8.319
01 Supervision			54 60	.079		.900	1.179
03 Labor			355 77	.512		.900	1.024
04 Maint., Labor			141 67	.204		.800	.811
05 " Material			152 45	.219		.750	.667
06 Maint., Labor			14 32	.020			
07 " Material							
08 Tools and Supplies			18 88	.027		.300	.283
09 Screen Cloth 10 Filter Cloth							
11 Steam			138 70	.200		.250	.603
12 Power			57 00	.082		.800	.575
13 Water 66 Chemicals, Infection			18 48	.027		.024	.045
14 Air 17 Stocking							
15 Gas			119 30	.172		.175	.182
16 Laboratory	1 17		45 38	.065		.120	.094
Direct Conversion	1 17		1,116 45	1.607		5.019	5.463
21 General Plant			133 44	.192		.700	.649
4? ? Payment 26 DIRECT MG. FARE							.065
25 Insurance and Taxes			36 28	.052		.075	.016
31 Depreciation			303 71	.437		.626	.202
Indirect Conversion			473 43	.681		1.403	.952
Total Conversion	1 17		1,589 88	2.288		6.422	6.415
02 Manufacturing Cost Bulk	1 17		7,309 70	10.519		15.998	14.734

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb.
31 Barrels						
31a Labor						
32 Kegs–Cans	24	3 63		69,423	192 18	.277
32a Labor					13 93	.020
33 Bags Cartons 34 Carboys	24			64	5 16	.031
33a Labor 34a Labor						
35 Tank Cars—Fee, Sleg						
35a Labor 38 Storing Drums					1 78	.003
38 Labor Sloting					12 87	.019
39 Maint. Storage Equip. & Bldgs.						
40 Loss in Repacking						
Total Packing Cost	—	3 63	—	69,487	226 22	.326
40 Dunnage 44						
42 Drayage 45		57			2 81	.038
43 Labor–Tank Cars						
44 Labor–Car Loads						
45 Labor–LCL	778	68		7,563	12 13	.160
47 Switching & Weighing						
48 Misc. Ship. Equip.					01	
Total Shipping Cost	778	$ 1 25	.175	7,563	$ 15 01	.198
Minimum Inventory		Bulk			Packed	
Opening Inventory		$		62,607	$ 6,725 56	10.750
Transferred In						
Produced				5,000	4 20	.001
Total to Account For				67,607	6,734 76	10.727
Closing Inventory				61,537	6,619 26	10.757
Disposed of				1,070	115 10	107.7
Shipped 7 Days		$		500	$ 36 11	
24				764	28 44	
Total				764	65 85	8.619
Used 6-1460-01-301				298	32 06	10.757
Surplus 6-1461-75				8	86	10.757

DSW 001442

ADA 000795

WATER_PCB-SD0000045962

EST BLDGS $ EQUIP. $ PRODUCT DISTILLED AROCLOR # 5442 156

EST TOTAL $ SYMBOL SCH 452 MONTH OF 1955

	THIS MONTH Amount	Per Lb	YEAR TO DATE Amount	Per Lb.	BUDGET Amount	Per Lb	Per Lb
425 CRUDE AROCLOR # 5042							
AROCLOR # 5042							

PACKING AND SHIPPING COST	THIS MONTH Pounds	Amount	Per Lb.	YEAR TO DATE Pounds	Amount	Per Lb.
Bags, Cartons	34 Carboys					
Labor	34a Labor					
Tank Cars - Per Stop						
Labor						
Leasing						
Maint. Storage Equip. & Bldgs						
Cost & Reworking						
Total Packing Cost						
Demurrage						
Tank Cars						
Labor						
Switching & Weighing						
Total Shipping Cost		Bulk		Packed		
Inventory						
Inventory						
Transferred in						

DSW 001443

ADA 000796

WATER_PCB-SD0000045963

COST, BLDGS. $ EQUIP. $ PRODUCT DISTILLED AROCLOR # 5460

COST TOTAL $ SYMBOL SCH 6-1453 MONTH OF May 1935

	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Amount	YEAR TO DATE Per Lb.	BUDGET Amount	BUDGET Per Lb.	1934 Per Lb.
Lbs.	—		—				
Capacity	—		—				
1423 CRUDE AROCLOR # 5060							1.180
AROCLOR LIME							.014
1123 CRUDE AROCLOR # 5060	$		$				9.752
544 AROCLOR LIME							.007
Total Raw Materials							9.759
Supervision							.810
Labor							1.018
Maint. Labor							.136
" Material							.129
Maint. Labor							
" Material							
Tools and Supplies							.327
Filter Cloth — 10 Filter Cloth							
Steam							.822
Power							.159
Water — 16 Electrodes or Fuel Oil							.047
Air — 17 Stocking							
Gas							.880
Laboratory	117		557				.275
Direct Conversion	117		557				3.803
General Plant							.379
Development							
Insurance and Taxes							.267
Depreciation							2.020
Indirect Conversion							2.666
Total Conversion	117		557				6.469
Manufacturing Cost Bulk	117		557				16.228
	$		$		$		

PACKING AND SHIPPING COST	THIS MONTH Pounds	THIS MONTH Amount	THIS MONTH Per Lb.	YEAR TO DATE Pounds	YEAR TO DATE Amount	YEAR TO DATE Per Lb.
Barrels						
Labor						
Bags—Cans						
Labor						
Bags—Cartons — 84 Carboys	24			58		
Labor — 84a Labor						
Tank Cars—Pcs. Bldg						
Labor — Stoking materials						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Lost in Repacking						
Total Packing Cost	—			—		
Dunnage 24						
Drayage 45					27	.031
Labor—Tank Cars						
Labor—Car Loads						
Labor—LCL	24	.07		870	1 91	.220
Switching & Weighing						
Total Shipping Cost	24	$ .02	.033	870	$ 2 16	.251

	Bulk			Pounds	Packed	Per Lb.
Minimum Inventory						
Opening Inventory		$		11,041	$ 1,894 10	17.155
Transferred In						
Produced					1 17	—
Total to Account For				11,041	1,895 27	17.166
Closing Inventory				11,017	1,891 15	17.166
Disposed of				24	4 12	17.166
Shipped 7 Drums		$			$ 1 04	—
				16	2 78	—
Total				16	3 82	23.87
Used						
14.75				9	1 37	17.166

DSW 001444

ADA 000797

WATER_PCB-SD0000045964

BLDGS. 8 EQUIP. 8

TOTAL 8

PRODUCT AROCLOR COMPOUNDS
SYMBOL SCH 6-1460 MONTH OF [illegible] 1935

	This Month Amount	This Month Per Lb.	Year to Date Amount	Year to Date Per Lb.	Budget Amount	Budget Per Lb.	1935 Per Lb.
Capacity							
Pounds of	[illegible]		[illegible]		1,300		
Aroclor 4465	[illegible]	170	[illegible]			.252	.252
Aroclor 5460			[illegible]			.542	.542
Aroclor 1260			[illegible]				
Aroclor 4465	[illegible]	[illegible]	[illegible]	[illegible]		4.067	3.069
Aroclor 5460			[illegible]	[illegible]		12.460	9.070
Aroclor 1260				[illegible]			
Prime Lard Oil							1.155
Raw Materials	[illegible]	1.224	[illegible]			16.533	14.125
							1.532
			[illegible]	[illegible]		.492	.464
Labor						.322	
Material							
Labor							
Material							
and Supplies			[illegible]			.970	.427
Cloth 10 Filter Cloth							
16 Electrodes or Fuel Oil							
17 Stocking							
	[illegible]	.327	[illegible]	[illegible]		.332	.18 / .569
Conversion	[illegible]	.321	[illegible]	[illegible]		2.115	3.173
Plant						.116	.139
Equipment							
Insurance and Taxes							
Depreciation							
Indirect Conversion						.185	.138
Total Conversion	[illegible]	.327	[illegible]	[illegible]		2.301	3.311
Manufacturing Cost Bulk	[illegible]	[illegible]	[illegible]	[illegible]		16.834	17.500

Packing and Shipping Cost	This Month Pounds	This Month Amount	This Month Per Lb.	Year to Date Pounds	Year to Date Amount	Year to Date Per Lb.
Barrels						
Labor						
Drums - Cans	[illegible]	[illegible]		[illegible]	[illegible]	
Labor						
Bags - Cartons 34 Carboys		[illegible]		[illegible]	[illegible]	
Labor 34a Labor						
Tank Cars - Fcc. Bing						
Labor						
Labor Storing						
Maint. Storage Equip. & Bldgs.						
Loss in Repacking						
Total Packing Cost	[illegible]	[illegible]	2.251	[illegible]	[illegible]	[illegible]
Dunnage						
Dispatch						
Labor—Tank Cars						
Labor—Car Loads						
Labor—LCL		[illegible]				
Switching & Weighing						
Total Shipping Cost	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	Bulk		Packed	
Minimum Inventory				
Opening Inventory		759	[illegible]	[illegible]
Transferred In				
Produced		[illegible]	[illegible]	[illegible]
Total to Account For		[illegible]	[illegible]	[illegible]
Closing Inventory		[illegible]	[illegible]	[illegible]
Disposed of		343	5 [illegible]	[illegible]
Shipped 71		[illegible]	8700	
[illegible]		[illegible]	5406	[illegible]
Used				
[illegible]		3	[illegible]	[illegible]

DSW 001445

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DSW 001446

ADA 000799

SECTION NO. 6

LABORATORY METHODS, SPECIFICATION AND EQUIPMENT

I. Analytical Methods

A. Plant Methods for Controlling Production of Crude Aroclors

1. Specific Gravity
2. Acidity
3. Softening Point of Solid Aroclors
4. Hold Point for Aroclors #1168 and 1169

B. Methods of Analysis for Aroclors as Used by Control Laboratory

1. Notes
2. Acidity of Distilled Aroclors
3. Specific Gravity of Liquid Aroclors
4. Tendency of Aroclor #2565 to Cause Blooming in Aroclor - Stearine Pitch Mixture
5. Hold Points for Aroclors #1168 and 1169
6. Acid Number of Crude Aroclors
7. Crystallization Test on Non-Crystalline Aroclors
8. Distillation Range of Liquid Aroclors
9. Total Chlorine in Aroclors
10. Free Chlorides in Liquid Aroclors
11. Pour Point of Aroclors
12. Loss on Heating of Aroclors
13. Color of Aroclor #5460
14. Coefficient of Expansion of Aroclors
15. Determination of Freezing Points
16. Determination of Benzol Insoluble in Solid Aroclors
17. Vaporization Loss at 66°C
18. Diphenyl in Crude Diphenyl or Diphenyl Still Bottoms
19. Dielectric Constant of Aroclors
20. Power Factor of Aroclors
21. Resistivity of Aroclors

II. Standard Specifications

1. Aroclor #1254, G.E. Compound No. 1476
2. Chlorinated Diphenyl, Crude, Aroclor 1119
3. Chlorinated Diphenyl, Crude, Aroclor #1142
4. Chlorinated Diphenyl, Crude, Aroclor #1148
5. Chlorinated Diphenyl, Crude, Aroclor #1150
6. Chlorinated Diphenyl, Crude, Aroclor #1154
7. Chlorinated Diphenyl, Crude, Aroclor #1160
8. Chlorinated Diphenyl, Crude, Aroclor #1162
9. Chlorinated Diphenyl, Crude, Aroclor #1168

DSW 001447

II. Standard Specifications
(Continued)

10. Chlorinated Diphenyl, Crude, Aroclor #1160
11. Chlorinated Diphenyl; H.B. Mix, Crude, Aroclor #2565
12. Chlorinated Diphenyl; H.B. Mix, Crude, Aroclor #4065
13. Chlorinated High Boiler, Crude, Aroclor #5060
14. Chlorinated Diphenyl, Distilled, Aroclor #1242
15. Chlorinated Diphenyl, Distilled, Aroclor #1248
16. Chlorinated Diphenyl, Distilled, Aroclor #1249
17. Chlorinated Diphenyl, Distilled, Aroclor #1251
18. Chlorinated Diphenyl, Distilled, Aroclor #1250
19. Chlorinated Diphenyl, Distilled, Aroclor #1252
20. Chlorinated Diphenyl, Distilled, Aroclor #1254
21. Chlorinated Diphenyl, Distilled, Aroclor #1258
22. Chlorinated Diphenyl, Distilled, Aroclor #1260 (Water Quenched)
23. Chlorinated Diphenyl, Distilled, Aroclor #1510
24. Chlorinated Diphenyl, Distilled, Aroclor #1546 (Comstock & Wescott)
25. Chlorinated Diphenyl; H.B. Mix, Aroclor #4465
26. Chlorinated High Boiler, Aroclor #5460, Distilled
27. Aroclor Moisture Proofing Compound Wax #501

III. Laboratory Test Equipment, Showing the Pieces Available for Transfer to St. Louis

SECTION 5

I. ANALYTICAL METHODS

A. Plant Methods for Controlling Production

SWANN CHEMICAL COMPANY

INSPECTION DEPARTMENT

REVISED, JUNE 22, 1935

DSW 001449

ADA 000802

PLANT METHODS FOR CONTROLLING THE PRODUCTION OF CRUDE AROCLORS

SPECIFIC GRAVITY

The temperatures at which the gravities of liquid Aroclors are taken vary with the viscosity of the liquid.

A metal cylinder of suitable size is provided for catching the sample from the chlorinator. The sample, after being caught, is cooled under the tap to within about 10°C of the temperature at which the gravity is to be taken. The hydrometer is then immersed in the liquid to a depth just sufficient to cover the bulb and is held in this position with the left hand while the liquid is stirred vigorously with the thermometer in the right hand. This stirring is continual until the temperature of the liquid is one degree above the desired gravity temperature. At this point the thermometer is quickly removed and the hydrometer allowed to sink gently as far as it will into the center of the cylinder of liquid. The hydrometer is read and this reading recorded as the gravity of the Aroclor.

The gravities of Aroclors 1119, 1142, 1148, 1150, and 1154 are taken at 65°C.

The gravities of Aroclors 1160 and 1162 are taken at 90°C.

The following table shows the limits within which each Aroclor should be finished.

1119	–	1.112 – 1.117
1142	–	1.345 – 1.350
1150	–	1.423 – 1.428
1154	–	1.503 – 1.507
1160	–	1.563 – 1.567
1162	–	No hydrometer (Must be finished by Westphal)

NOTES

Be sure the sample is stirred well but carefully in order to avoid breakage.

The hydrometer should be read as quickly as possible, since the temperature drops would give a wrong reading.

DSW 001450

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ACIDITY

Approximately 35 cc of the liquid aroclor (or 50 grams of a solid aroclor) is poured into a 250 cc beaker. To this 100 cc of alcohol-benzol mixture (furnished by the laboratory) is added. The mixture is titrated with N/10 caustic solution (also obtained from the laboratory). Before the titration is started a little water is added from the tap. When the end point is reached the water layer will be colored pink. The blowing operation is complete when less than 8 cc of the caustic solution are required to reach the end point.

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ADA 000804

WATER_PCB-SD0000045971

SOFTENING POINT OF SOLID AROCLORS
Ball and Ring Method

Preparation of the Sample

The sample shall be melted and stirred thoroughly, avoiding overheating or incorporating air bubbles in the mass and then poured into the ring so as to leave a slight excess on cooling. Since the Aroclors shrink considerably on cooling, the ring should be well filled, nearly to overflowing. A little of the excess should be drawn over the top of the ring at several points so as to prevent the cooled Aroclor from dropping out of the ring. In the same way, the second ring is filled with a standard Aroclor of known softening point. The standard Aroclor should have a softening within at least 10 to 15° of the Aroclor being tested.

The rings while being filled should rest on a clean can lid or on a brass plate which has been amalgamated to prevent the aroclor from adhering to it. The Aroclor in the rings should be fully cooled and hardened before proceeding with the test.

Procedure

Add water (not above room temperature) to the beaker until the surface of the water is 2" above the plate holding the rings when the ring support is suspended in the beaker. Place the rings containing the Aroclor to be tested and the standard Aroclor on the ring support. Place a ball on the center of the upper surface of the Aroclor in each ring. Suspend the thermometer so that the bottom of the bulb is level with the bottom of the rings and just midway between the two rings.

Place beaker and apparatus on a 6 inch round hot plate and heat.

The temperature recorded by the thermometer at the instant the Aroclor touches the bottom plate is reported as the softening point. The heating is continued until both Aroclors have dropped to the bottom plate.

Notes

1. The standard Aroclor is run along with the sample under test in order to compensate for variations in rate of heating, dilution of glycerin, and thermometer variations.

2. Benzol is used for cleaning the rings and balls. DSW 001452

3. Water can be used instead of glycerin for softening points up to 90°C.

4. For softening points above 100°C, well boiled glycerin should be used. The usual glycerin is not satisfactory as at 125 to 130°C, it boils with loss of water while the temperature remains practically constant. It is well to have a supply of high-boiling glycerin on hand to be used only for softening points above 100°C.

5. Air bubbles on the rings and balls during the test should be avoided as far as possible.

HOLD POINT FOR AROCLORS 1168 & 1169

Description of Apparatus

The receptacle for the Aroclor is a 4-1/2 x 1" glass tube which has been sealed at one end. This tube is jacketed by a piece of asbestos paper wrapped twice around the tube and is inserted in a square eight ounce bottle which is insulated on the bottom by a layer of 1 inch asbestos fibre. The tube is held in place by a large cork. All of this insulation is used in an effort to keep the Aroclor from cooling too rapidly and it is best to get additional insulation by wrapping the eight ounce bottle in a towel after the sample is added.

Procedure

Melt about 100 gms. of the sample in a beaker on the hot plate and pour it into the tube until it is filled within 1-1/2" of the top. The material will probably crystallize due to the cold tube and will have to be heated over a gas burner to melt it again. When it is melted insert a suitable thermometer (300-360°C) which is fitted with a cork to hold it in place. The bulb of the thermometer should be fitted in the center of the sample, care being taken that it is not too close to the side of the tube.

If the determination is made on 1169 or 1269 the tube should be heated until the thermometer reads about 300°C and it is placed in the asbestos jacket and then put in the bottle. Readings on the thermometer are taken at 30 second intervals. At first the temperature will drop rapidly (about 6° between readings) but around 250° the drop will decrease and usually a point will be reached where the drop will stop, and will either stay constant for two or more readings or will start to go back up. The correct hold point is the point at which the temperature remains constant or in case the temperature starts to go back up the highest point in this rise is taken. For example: 346, 343, 340, 338, 339, 342, 339, 337. 342°C would be the correct hold point.

In the case of 1168 or 1268 the procedure is the same except that the tube is heated to only 200°C instead of 300°C after the thermometer is inserted.

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SECTION 5

I. ANALYTICAL METHODS

B. Methods of Analysis for Aroclors as Used by Control Laboratory

SWANN CHEMICAL COMPANY

INSPECTION DEPARTMENT

REVISED, JUNE [illegible], 1955

NOTES ON AROCLOR TESTING

A number of A.S.T.M. Methods are used in testing Aroclors, including such tests as:

Fire Point	D-92
Flash Point	D-92
Viscosity-Saybolt	D-88
Softening Point	D-36

The A.S.T.M. directions are exactly followed for such tests.

Color, Lovibond. For color of liquid Aroclors, the Lovibond Tintometer with 1" cell is used. Standard oils of the National Petroleum Association (N.P.A. Standards) are reported to be no longer available. The following conversion table is used:

N.P.A. Color Numbers	Lovibond Analysis Yellow 510	Red 200
1/4	.6	
1/2	1.1	
3/4	1.7	
1	2.4	.12
1-1/2	8.0	.60
2	26.0	2.50

Dielectric Strength: ASTM D - 117, No equipment has been installed at Anniston for making this test.

Loss on Heating: 6 hours at 100°C. This test is similar to A.S.T.M. Test D-6 except that oven is maintained at 100°C and time of testing is extended to 6 hours. This test is used on G.E. material where so specified. A 40 gm. sample is used in the place of 50 gms.

gre

DSW 001455

ADA 000808

DIRECTIONS FOR TEST NO. 14-43-35

SUBJECT: Acidity of Distilled Aroclors

METHOD: NaOH Titration

(50 ± 1) grams of the Aroclor are weighed into a 250 cc beaker and 100 cc of C.P. benzene added. After solution has been effected the sample is titrated with .01 N alcoholic NaOH solution, using 1 cc (about 20 *drops*) of 1% phenolphthalein solution as an indicator. The end point is reached when the solution is visibly pink throughout. Rapid stirring should be used while the NaOH solution is being added. The results are reported in mg. of NaOH per gram of sample.

It is unusual for a distilled Aroclor of the 1200 series to require more than .5 cc titration, which is equivalent to .004 acid No.

The alcoholic NaOH solution is prepared by making up 5 cc of N/2 aqueous caustic solution to 250 cc volume with 95% alcohol (Formula 3A).

ers

DIRECTIONS FOR TEST NO. 14-10-52

SUBJECT: Specific Gravity of Liquid Aroclors

METHOD: Westphal Balance

General

Specific gravity is determined by means of the Westphal balance. The temperatures at which the specific gravities of liquid Aroclors are taken vary with the viscosity of the liquid. The specifications for each Aroclor should state the temperature for both the Aroclor and the water to which comparison of gravity is made. In plant practice, specific gravities of Aroclors containing up to 54% chlorine are made at 65/65°C while specific gravities of Aroclors containing 60-62% chlorine are made at 90/90°C.

Specific gravities of any of the Aroclors may be made at 25/25°C by use of the A.S.T.M. method for road tars, asphalt cements, soft tars pitches, serial designation D70-27, 1927 (described in Bureau of Standards Miscellaneous Publication No. 110, Standards and Specifications for Nonmetallic Minerals and their products, page 125.)

Apparatus

Westphal Balance: Similar to Eimer and Amend Catalog No. 16950. Plummet need not have thermometer scale to 90°C but should not be subject to injury by use at this temperature.

Cylinder: Pyrex glass hydrometer jar 1.5" x 6".

Thermometer: Use thermometer which has been checked for accuracy of scale in the range used.

Procedure

Place the Westphal in such position that the plummet is 7 - 9 inches above the work bench. By means of the leveling screw, adjust the Westphal balance to show zero reading with a clean dry plummet in air. Suspend the plummet during adjustment in a empty cylinder to protect the apparatus from air currents.

Heat the Aroclor to be tested to a temperature about 15° higher than the temperature at which determination is to be made. For example, if specific gravity is wanted at 65°C, the Aroclor should be heated to about 80°C. Then pour the heated Aroclor into a clean Pyrex cylinder which has been warmed by setting at edge of hot plate. The cylinder should be filled with the Aroclor to within about 1 inch of the top.

Page 2 DIRECTIONS FOR TEST NO. 14-10-32

SUBJECT: ______

METHOD: ______

Allow the Aroclor in the cylinder to air cool until the temperature is about 7 degrees above that desired, then place the cylinder in a hot water bath which is at a temperature about 5 degrees above the desired temperature. A liter beaker containing sufficient water to be equal to or above the level of the Aroclor in the cylinder is a satisfactory water bath. In case the Specific Gravity is to be taken at 90/90°, a glycerin bath should be substituted for the water bath to avoid the water vapor with its condensation on the Westphal balance which is present if water is used at high temperatures such as 95°C.

Without disturbing the adjustment of the Westphal which is set to read zero with plummet in air, place the cylinder containing the Aroclor in such position that the plummet is immersed in Aroclor and add weights to the beam of the Westphal until the beam is again level. The plummet should now be completely immersed as well as about 1/2" of the suspension wire and the plummet should not touch the cylinder at any point. Stir the Aroclor with a thermometer at frequent intervals until the desired temperature just is reached. At this point the weights are quickly adjusted until equilibrium is obtained and the reading noted.

Having obtained the reading for Aroclor at the desired temperature, the specific gravity is obtained by dividing this figure by the reading when the plummet is immersed in pure water at the same temperature. The reading for water is obtained in the same manner as for Aroclor. Since the reading for water is constant, provided there are no errors in weights or Westphal, this figure need not be determined with each Aroclor test. The figure for water which is used as a constant should, however, be checked once a month or whenever greatest accuracy is needed. The readings for water at 65°C and 90°C are respectively .9828 and .9672.

Calculation of Result

Example 1. Assume readings as follows:

Westphal reading with plummet in air	Zero
Westphal reading with plummet in Aroclor at 65°C	1.5025
Westphal reading with plummet in water at 65°C	.9828

Then sp. gr. at 65/65°C $= \frac{1.5025}{.9828} = 1.5288$

Example 2. Assume readings as follows:

Westphal reading with plummet in air	Zero
Westphal reading with plummet in Aroclor at 90°C	1.5435
Westphal reading with plummet in water at 90°C	.9672

Then sp. gr. at 90/90°C $= \frac{1.5435}{.9672} = 1.5958$

DSW 001458

ADA 000811

Page 5 DIRECTIONS FOR TEST NO. 14-20-32

SUBJECT:

METHOD:

Notes

1. The weights used with the Westphal balance should be checked periodically by weighing each on an analytical balance.

2. The adjustment of the liquid to the exact temperature desired is most important. Do not allow to cool rapidly and stir frequently enough to maintain a uniform temperature from top to bottom in the cylinder.

ers

DSW 001459

DIRECTIONS FOR TEST NO.________________

SUBJECT: Tendency of Aroclor 2565 to cause Blooming in Aroclor-Stearine Pitch Mixture

METHOD: Seeding and Incubation

Weigh out 10 grams of Aroclor 2565 and 15 grams of stearine pitch. Melt the Aroclor in a beaker and add the stearine pitch in two or three portions, stirring all the time and gradually raising the temperature over a period of five to 10 minutes to 180°C to 200°C. Stirring is continued at this temperature until a uniform mixture has been obtained. This may require 10 minutes or more. The pitch is added to the melted aroclor so as to avoid excessive oxidation of the pitch.

When the mixture is uniform and reasonably free from foam it is at once poured into a small salve tin (the tin 2" in diameter is a convenient size). The salve tin is covered and the mixture allowed to cool.

When cooled to room temperature the tin is opened and the surface of the Aroclor-stearine pitch mixture is "seeded" with crystals. The seeding operation consists simply in rubbing the finger lightly over a sample of Robertson roofing which has bloomed badly or over a previous test sample of an Aroclor-stearine pitch mixture that is covered with bloom so as to pick up a trace of the bloom on the finger-tip and then finger printing the new Aroclor-stearine pitch mixture with the same finger. Care must be taken not to pick up too much of the white bloom and transfer it to the new test mixture as the "seed" may then be mistaken for bloom.

The salve tin containing the seeded sample is covered and is then placed in a warm space at about 40°C.

At the end of three days the sample is inspected and if very distinct bloom has not developed the surface is rubbed over with the finger tip so as to spread the seed crystals that are already present over the entire surface. The sample is then re-seeded in two spots as before by finger printing with a finger that has been lightly rubbed over a surface covered with the bloom.

The sample is inspected twice weekly for the appearance of bloom. The bloom appears first as a slight dulling of the surface, then as a whitish powder on the surface and finally under the microscope as white transparent needle-like crystals. In the case of an Aroclor with a strong tendency to bloom the white coating develops within two weeks. In the cases where bloom does not appear by the end of two weeks the tests should be continued to at least four weeks before a negative result is reported. Five weeks is safer.

Page 2 DIRECTIONS FOR TEST NO.________________

SUBJECT: Tendency of Aroclor 2565 to Cause Blooming etc.

METHOD:________________

Notes

The preparation of a homogeneous mixture of Aroclor and stearine pitch free from excessive foam when the mixture is ready to pour into the salve tin apparently requires some experience.

The stearine pitch is a "soft pitch" obtained from Mr. P. W. Jenkins of Mellon Institute, Pittsburgh, Pennsylvania, for use in the test for blooming.

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DSW 001461

ADA 000814

DIRECTIONS FOR TEST NO.

SUBJECT: Hold Points for Aroclors 1168 & 1169

METHOD:

Description of Apparatus

The receptacle for the Aroclor is a 4 1/2 x 1" glass tube which has been sealed at one end. This tube is jacketed by a piece of asbestos paper wrapped twice around the tube and is inserted in a square eight-oz. bottle which is insulated on the bottom by a layer of 1" asbestos fibre. The tube is held in place by a large cork. All of this insulation is used in an effort to keep the Aroclor from cooling too rapidly and it is best to get additional insulation by wrapping the eight-oz. bottle in a towel after the sample is added.

Procedure

Melt about 100 gms. of the sample in a beaker on the hot plate and pour it into the tube until it is filled within 1 1/2" of the top. The material will probably crystallize due to the cold tube and will have to be heated over a gas burner to melt it again. When it is melted insert a suitable thermometer (300-360°C) which is fitted with a cork to hold it in place. The bulb of the thermometer should be fitted in the center of the sample, care being taken that it is not too close to the side of tube.

If the determination is made on 1169 or 1269 the tube should be heated until the thermometer reads about 300°C and it is placed in the asbestos jacket and then put in the bottle. Readings on the thermometer are taken at 30 sec. intervals. At first the temperature will drop rapidly (about 6° between readings) but around 250° this drop will decrease and usually a point will be reached where the drop will stop, and will either stay constant for two or more readings or will start to go back up. The correct hold point is the point at which the temperature remains constant or in case the temperature starts to go back up the highest point in this rise is taken. For example: 346, 343, 340, 338, 338, 339, 342, 339, 337. 342°C would be the correct hold point.

In the case of 1168 or 1268 the procedure is the *same* except that the tube is heated to only 200°C instead of 300°C after the thermometer is inserted.

In all readings a stem correction is made (unless partial immersion thermometer is used) by use of the following formula:

DSW 001462

Stem correction = K x N (T-t)

K = Factor for expansion of mercury in glass = .000155
N = Length, expressed in degrees, of the mercury column emergent from the bath.
T = Observed thermometer reading.
t = Mean temperature of the emergent stem which is found by placing a *second* thermometer at the middle of the exposed thread of mercury.

ADA 000815

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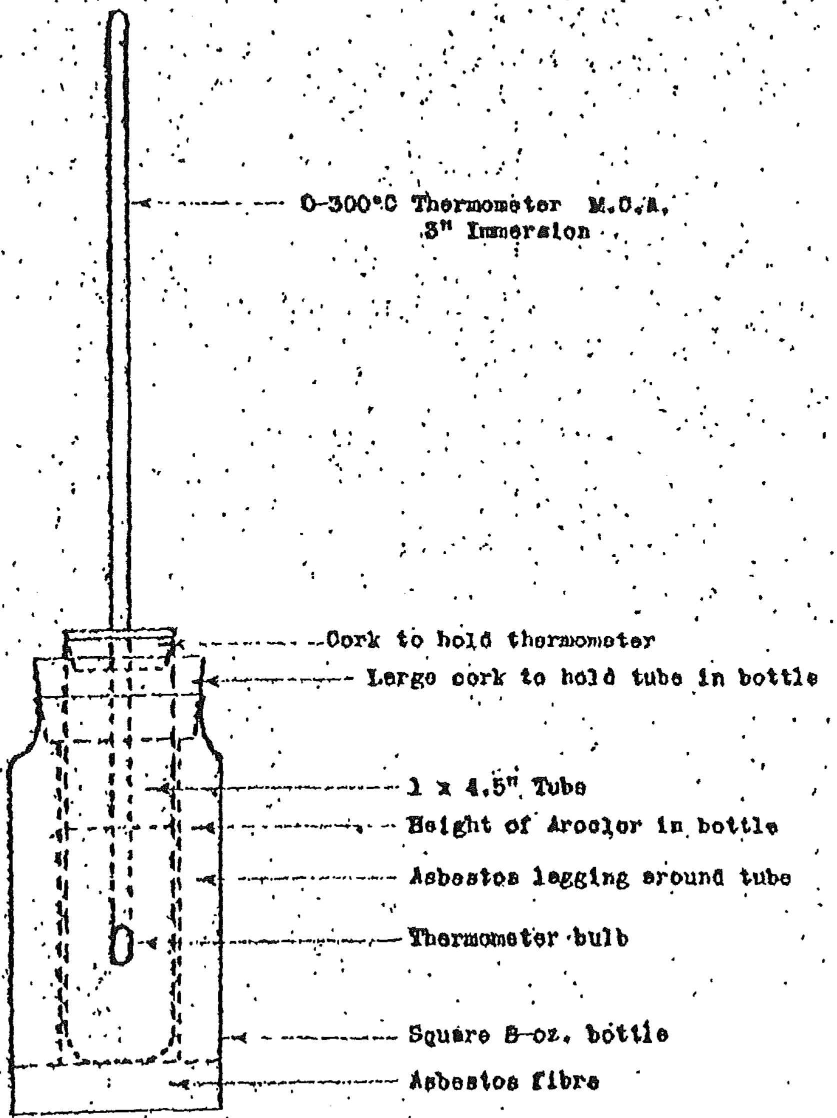

DSW 001463

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ADA 000816

WATER_PCB-SD0000045983

DIRECTIONS FOR TEST NO. ~~14-14-55~~

SUBJECT: Acid Number of Crude Aroclors

METHOD: NaOH Titration

Procedure

Dissolve 50 grams of Aroclor in 50 cc C.P. benzol contained in a 250 cc beaker. Add 50 cc of 95% ethyl alcohol and titrate with 0.1 NaOH solution using 10 drops of 1% phenolphthalein solution as indicator. Before starting the titration, a little distilled water is added; this causes sharper and quicker separation of the aqueous layer from the non-aqueous layer. Calculate the acidity in milligrams of NaOH required per gram of sample. On account of the strong NaOH solution used for titration, the blank titration of the reagents may be omitted.

$$\text{Mgm NaOH per gram sample} = \frac{\text{titration in cc} \times 20}{\text{wt. of sample}}$$

Example: If the titration of 50 grams of sample is 1.2 cc, the acid number is found as follows: 1.2 x 20 divided by 50 = .48 Mgm NaOH per gram of Aroclor.

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DSW 001464

DIRECTIONS FOR TEST NO. 14-40-34

SUBJECT: Crystallization Test on Non Crystalline Aroclors

METHOD: Solution in V M & P Grade Naphtha

Procedure

The test is based on the relative insolubility of crystalline Aroclors in naphtha.

Weigh 60 grams of powdered Aroclor (preferably finely powdered) into a wide mouth 8 ounce bottle. Add 40 grams of naphtha and stopper tightly. Shake until solution is complete but do not warm to hasten solution. Set aside for 3 days. If no crystallization takes place within this period the material is considered satisfactory.

Reagents

Naphtha

Varnish makers and Painters grade. Initial boiling point 195-212°F and end point 320-335°F. Obtainable from Wofford Oil Company, Birmingham, at 16¢ per gallon.

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DSW 001465

ADA 000818

DIRECTIONS FOR TEST NO. 14-31-52

SUBJECT: Distillation Range of Liquid Aroclors

METHOD: A.S.T.M. D20-30 With Modifications

The apparatus, consisting of flask, condenser tube, shield, and thermometer, is exactly the same as described under A.S.T.M. test D20-30 "Distillation of Bituminous Materials suitable for Road Treatment". The method is changed to the extent that thermometer readings are taken when specified percentages (usually 10, 50, 90%) of Aroclor have been distilled instead of following the A.S.T.M. procedure of weighing the distillate between specified thermometer readings. In testing Aroclors 1254, 1248, 1242, etc., 100 cc of sample are taken for test and the distillate is received in a 100 cc graduated cylinder. In testing Aroclor 1260, 100 gms. of sample is weighed into the distilling flask and distillate received in a tared flask or beaker resting on pan of a torsion balance with 100 gram scale.

Procedure

Transfer 100 cc of sample (weigh 100 grams in the case of Aroclor 1260) into the distilling flask. Assemble apparatus as described under A.S.T.M. D20-30. Insert thermometer (A.S.T.M. high distilling 0-400°C) through cork in the neck of the flask so that the top of the bulb is level with the lowest point of juncture of the tubulature and neck of the flask. Apply heat to the flask supported on two sheets of 20 mesh wire gauze so that the first drop comes over in from 5 to 15 minutes.

Conduct distillation at rate of 50 to 70 drops per minute. Collect distillate in 100 cc graduated cylinder (or tared flask in case of Aroclor 1260). When 10% has been collected as distillate, note and record the thermometer reading. Repeat when 50 and 90% has been collected. For record purposes the temperature when first drop falls and when each successive 10% has been collected (up to 90%) should usually be recorded even where specifications require only the 10, 50, and 90% readings.

No corrections for emergent stem or pressure are applied to the thermometer readings.

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DSW 001466

ADA 000819

DIRECTIONS FOR TEST NO. 14-13-34

SUBJECT: Total Chlorine in Aroclors

METHOD: Peroxide Fusion & $AgNO_3$ titration

REFERENCE: Beamish, Determination of Organic Halogens, I. & E.C., Anal. Ed. 6, 5, 352 (1934).

Chlorine in Aroclors may be determined by fusion of the sample with sodium peroxide in a Burgess-Parr fusion cup, extracting the fusion with water, acidifying the water extract with nitric acid, and precipitating the chlorine by addition of an excess of silver nitrate. After filtration, the excess of silver nitrate is determined by titration against potassium thiocyanate, using ferric ammonium sulfate as indicator.

Apparatus

The fusion cup used is the Burgess-Parr Sulfur Bomb No. 3 for flame ignition. A lead gasket is used. For ignition, the bomb is suspended through a 1-3/16" round hole in a 1/8" transite plate. This allows the fusion cup to extend through the plate for about 5/8". Ignition is effected by strongly heating the bottom of the fusion cup with the full flame of a Meker burner for two minutes.

Charge for Fusion

The fusion mixture is made up of about 15 grams (one metal scoop) of sodium peroxide and 0.0 to 0.3 grams of finely powdered cane sugar, the amount of cane sugar depending upon the weight of carbon contained in the sample. The reagents should be free from chlorine, or a blank run and corrected accordingly. The fusion mixture is well mixed by placing the ingredients in a small bottle with rubber stopper and shaking vigorously.

SOLID AROCLORS: The non crystalline type are weighed in the form of small pellets. These are prepared by heating the Aroclor until such a consistency is reached as will permit dropping it from a glass stirring rod onto a tinned surface (a can top), each drop forming a pellet. When cool these pellets can be removed from the surface by inserting a spatula under them. .4 grams are used. The pellets are brushed into the bottom of the fusion cup and the fusion mixture placed on top of them. After tightening the lid, the charge is ready for fusion.

The crystalline type is weighed in the powdered form, .4 grams being used. They are charged in the same manner as the non-crystalline type.

DSW 001467

LIQUID AROCLORS: .20 to .30 grams are weighed by dropping from a stirring rod onto a piece of thin hemispherically shaped glass, which has been just previously tared, and which remains on the balance. It is necessary to heat the more viscous Aroclors to "dropping" consistency. The piece of glass then easily slides off the balance pan into the fusion cup.

Page No. 2 DIRECTIONS FOR TEST NO. 14-13-34

SUBJECT:

METHOD:

The following quantities of sample, sugar, and $AgNO_3$ are used for the respective chlorine contents:

Cl Content	Weight of Sample	Amount Sugar	$AgNO_3$
0.% – 30%	.16 – .20 Grams	0.0	50 cc
30% – 45%	.28 – .30 "	.15 g.(1/2 scoop)	50 cc
45% – 58%	.28 – .30 "	.30 g.(1 scoop)	50 cc
58% – 66%	.40 – .41 "	.30 g. "	75 cc
66% – 70%	.40 – .41 "	.30 g. "	100 cc

Procedure

Place the fusion cup, which contains the prepared sample and fusion mixture, in the transite ignition plate and apply the full flame of the Meker burner to the bottom of the fusion cup for 2 minutes.

(CAUTION: Do not stand too near the fusion during ignition)

Then remove the flame and cool under the tap. When cool remove screw cap. Thoroughly rinse the cup cover with water, collecting the rinsings in a clean 400 cc beaker.

Then place the fusion cup on its side in the beaker and cover with a watch glass. 50 – 75 cc will be in the beaker from rinsing the cap, and this is sufficient to decompose the charge. Remove the cup and rinse well. When decomposition is complete rinse off cover glass and add pure HNO_3, with stirring, until acid is present in excess to the extent of about 10 cc. (About 50 cc of acid are required.)

Add exactly 50, 75 or 100 cc of standard silver nitrate solution from a pipette (depending upon chlorine present) and stir to effect coagulation of the silver nitrate precipitate. Filter with suction through an asbestos pad on a 1.5" perforated porcelain plate and wash beaker and filter 4 times with small portions of cold water. Allow the filter to drain completely between washings. Transfer the filtrate back into the 400 cc beaker and rinse the flask twice, adding the rinsings to the beaker.

Add 5 cc of ferric iron indicator to the solution and titrate with standard KCNS solution until a distinct pink tint is just obtained.

DSW 001468

Calculation of Chlorine Content

Subtract the volume of KCNS required from the volume of KCNS required to titrate the amount of standard $AgNO_3$ solution used. This will give

ADA 000821

Page No. 3 DIRECTIONS FOR TEST NO. 14-13-34

SUBJECT:

METHOD:

the volume of KCNS equivalent to the chlorine in the sample. Multiply the volume so obtained by the chlorine value of each cc of KCNS and divide by the weight of sample taken.

For example: If 50 cc of silver nitrate solution is equivalent to 61.4 cc of KCNS solution and the value of 1 cc of KCNS solution is .003770 gram Cl; then if it is found that 0.3 gram of sample shows a KCNS titration of 10.4 cc the percent of chlorine is:

$$\frac{(61.4 - 10.4) \times .003770 \times 100}{.3} = 64.09\% \text{ Cl}$$

In case the fusion mixture or other reagents contain chlorine, the amount must be determined and deducted from the chlorine found.

Solutions Required

Standard $AgNO_3$ Solution: About 0.10 N; dissolve 19.6 grams of silver nitrate in each liter of water. Protect the solution from light. Fifty cc of this solution will precipitate by theory 0.175 gram of chlorine.

Standard KCNS solution: About 0.08 N; dissolve 8 grams of KCNS in 1 liter of water. 1 cc = about .003 gram chlorine.

Ferric Iron Indicator: Use a saturated solution of ferric ammonium alum.

Pure Nitric Acid, 70%: Stock acid suffices provided it is colorless. It can be boiled in a beaker until colorless if necessary.

Standardization of Solutions

Weigh 0.3 and 0.15 gram portions of pure dry NaCl into separate 600 cc beakers. Add 250 cc of distilled water to each and 10 cc of pure 50% nitric acid. When solution is complete, add 50 cc of standard $AgNO_3$ solution from pipette. Stir well and filter through an asbestos mat on a perforated porcelain plate, using suction. Wash filter and transfer the filtrate back to the beaker in the same manner as when working with a sample. Titrate the filtrates with standard KCNS solution, using ferric iron indicator.

DSW 001469

The value of 50 cc of $AgNO_3$ solution in terms of KCNS solution is found by subtracting the cc of KCNS solution in titrating the 0.3 gram of NaCl from twice the number of cc of KCNS solution used in titrating the 0.15 gram of NaCl.

Page No. 4 DIRECTIONS FOR TEST NO. 14-13-34

SUBJECT:

METHOD:

This value is checked by titrating 50 cc of $AgNO_3$ solution added to 400 cc of water and 10 cc of pure 50% HNO_3 with KCNS solution. This titration should agree very closely (+1 0.1 cc) with the value found from the titrations of NaCl. The titration must be made slowly to avoid drainage error.

Since pure NaCl contains 60.66% Cl by theory, the value of the KCNS in terms of chlorine may be found by dividing the weight of chlorine in the NaCl taken by the cc of KCNS equivalent to the silver nitrate required.

Example:

Two 0.5 gram portions of NaCl show KCNS titrations of 13.11 and 13.13 cc.

Two 0.15 gram portions of NaCl show KCNS titrations of 37.28 and 37.24 cc.
The KCNS equivalent to 50 cc of $AgNO_3$ is then (37.28 + 37.24) — 13.12 or 61.4 cc.

By titration of 50 cc of $AgNO_3$ against KCNS solution, it is found that 61.36 cc are required. This agrees within .04 cc of the value obtained from the NaCl titrations.

The chlorine value of the KCNS is then, .6066 x .5 divided by 61.4 — 13.12 or .003770 grams Cl per cc of KCNS.

The chlorine value may also be calculated from the titration of 0.15 gram of NaCl. 0.6066 x .15 divided by 61.4 — 37.26 gives .003770 grams Cl Per cc of KCNS.

Notes

1. The fusion materials have explosive properties if wrongly handled; consequently care must be taken to use safe proportions, to secure a good mixture free of large lumps, and to properly seat the cover of the fusion cup. The fusion mixture must be kept away from water or moist air, either of which may ignite the charge. The fusion mixture should not be ground to reduce lumps.

2. The method as described is not applicable to volatile organic compounds unless precautions are taken to avoid loss of sample during weighing.

Page No. 5 DIRECTIONS FOR TEST NO. 14-13-54

SUBJECT:

METHOD:

3. On account of the high chlorine content of many of the Aroclors and the small amount of sample taken, great accuracy is required in weighing, transfer, and mixing of the sample. The pipette and burette for measuring the standard solutions must be very clean to avoid drainage errors.

4. Fusions which show black carbon deposites on the cover and side of the fusion cup may or may not give the full chlorine content. If a carbon deposit is found, a second fusion should be made using a smaller sample or reducing the amount of sugar in the charge or both.

5. Mixing the fusion charge by shaking after the screw cap has been drawn down may lead to incomplete fusions. The mixing of the sample with the fusion mixture should be done in such a way that the sample is fully covered with the mixture.

6. The temperature at which the standard solutions are standardized should be noted. In case room temperatures vary from this temperature, appropriate volume corrections should be made.

7. The fusion mixture materials should be essentially free of chlorine. The chlorine content may be determined by making a blank fusion, that is, without addition of sample, and titrating in the usual way. Five cc of $AgNO_3$ may be added instead of 50 cc. The KCNS titration is then compared with titrations of 5 cc portions of $AgNO_3$ solution in like volumes of solution and nitric acid.

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DSW 001471

DIRECTIONS FOR TEST NO. ~~14-38-34~~

SUBJECT: Free Chlorides in Liquid Aroclors

METHOD: Opalescence of Water Extract with $AgNO_3$

Procedure

Weigh 50 grams (± 1 gram) of sample into a 250 cc erlenmeyer flask. Add 100 cc of boiling hot water, stopper and thoroughly shake for 2 to 3 minutes. Cool in a water bath. Decant the water layer through a filter paper into a 150 cc beaker.

Add 1 cc of HNO_3 and 3 cc of 0.1 N $AgNO_3$ solution. At the same time add like amounts of reagents to each of three 150 cc beakers containing (1) 100 cc of water, (2) 100 cc of water + 0.5 cc of standard .0282 N NaCl solution and (3) 100 cc of water + 1 cc of standard NaCl solution. Mix contents of each beaker by stirring. Four minutes after mixing, compare the turbidity of the sample against the turbidities of the known solutions.

A sample showing turbidity less than produced by the 0.5 cc NaCl solution (equivalent to .001%) should be reported as .000. Samples showing turbidities equal to or greater than the 0.5 cc NaCl solution should be estimated as closely as possible from standard NaCl solutions at 0.5 cc intervals.

0.5 cc NaCl solution	=	.001% Cl
1.0 cc NaCl solution	=	.002% Cl
1.5 cc NaCl solution	=	.003% Cl etc.

Solutions Required

Standard NaCl solution, .0282 N, 1 cc = .001 gm Cl. Dissolve 1.649 grams pure dry NaCl in sufficient water to measure 1 liter.

Silver Nitrate solution, 0.1 N (1.7%). Dissolve 17 grams of dry silver nitrate in sufficient water to measure 1 liter. 1 cc = .017 gm. $AgNO_3$. 1 cc is equivalent to .0035 gm. Cl or to 3.5 cc of the standard .0282 N NaCl solution.

DSW 001472

Notes

Determination of free chlorides is usually confined to Aroclor 1254.

The method above is elaborated from ASTM Method D117-31, Testing Electrical Insulating Oils, paragraph 13, Mineral Acids (chlorides and sulfates).

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ADA 000825

DIRECTIONS FOR TEST NO. 14-23-52

SUBJECT: Pour Point of Aroclors

METHOD: ASTM D97-50 — Cloud and Pour Point

ASTM Definition

"The pour point of a petroleum oil is the lowest temperature at which the oil will pour or flow when it is chilled without disturbance under definite prescribed conditions." The method of test below follows ASTM directions exactly except that observations are made at intervals of 2°C instead of 5°F and results are reported on Centigrade scale.

Apparatus

A sketch of the assembled apparatus is attached. For details of apparatus see ASTM D97-50.

Procedure

Pour the Aroclor into the clean dry test jar to a height of 2 to 2 1/4". Insert cork carrying the test thermometer and adjust so that the thermometer is in the center of the test jar and the beginning of the capillary is 1/8" below the surface of the Aroclor. Warm without stirring to a temperature of 46°C in a bath at 48°C. Cool to 30°C in an air or water bath.

Adjust temperature of the cooling bath so that it is 8 to 16°C below the expected pour point of the Aroclor and maintain in this range throughout the test. Place disk (e) in bottom of jacket and insert test jar (with the ring gasket, f, 1 inch above the bottom) into the jacket. Disk, gasket and inside of jacket must be clean and dry.

Beginning at a temperature 10°C before the expected pour point, at each test thermometer reading which is an even number, carefully remove test jar and tilt just enough to ascertain whether there is a movement of the Aroclor in the test jar. The complete operation of removal and replacement should not require more than 3 seconds.

If the sample has not ceased to flow when its temperature has reached 8°C, place the test jar directly in a cooling bath of suitable temperature. As soon as the sample in the test jar does not flow when the jar is tilted, hold the test jar in a horizontal position for exactly 5 seconds as measured by a stop watch. If oil shows movement, replace test jar in cooling medium and repeat test at the next temperature 2°C lower.

Continue testing in this manner until a point is reached at which the sample shows no movement when the test jar is held horizontally for exactly 5 seconds. Note the thermometer reading at this solid point. The pour point is recorded as the temperature 2°C above the solid point.

DSW 001473

ADA 000826

Page No. 2 DIRECTIONS FOR TEST NO. 14-23-38

SUBJECT:

METHOD:

Notes

The cooling mediums usually employed are shown below:

Material	Approx. Pour Point	Cooling Medium	Lower Limit for Medium
Aroclor 1260	28°C	Ice and Water	10°C
Aroclor 1254	10°C	Ice, Water and Salt (NaCl)	—
Aroclor 1248	-6°C	Crushed ice and salt	-12°C
Aroclor 1242	-20°C	Gasoline and solid CO_2	-55°C

Crushed ice and calcium chloride crystals may be used for temperatures down to -25°C.

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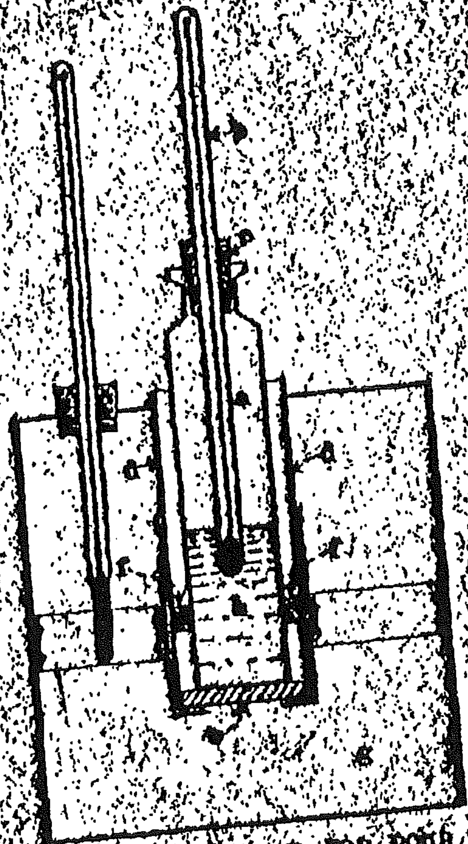
DSW 001474

DIRECTIONS FOR TEST NO. 14-23-38

SUBJECT: Pour Point of Aroclors

METHOD: ASTM Designation D97-30



ASSEMBLED APPARATUS FOR POUR TEST

a. Test Jar, 4 oz. oil sample bottle, 1 3/16 to 1 5/16" I.D.
b. Test Thermometer, "ASTM Cloud & Pour -38 to +50°C," placed so that beginning of capillary is 1/8" below surface of oil.
c. Cork to fit test jar, center bored for test thermometer.
d. Jacket, water tight cylinder, with inside diameter 3/8 to 1/2 in. greater than O.D. of test jar.
e. Disk of cork or felt, 1/4" thick, to fit bottom of jacket.
f. Ring gasket, cork or felt, to prevent test jar from touching jacket, fits test jar tightly and loosely into jacket.
g. Cooling Bath with support for holding jacket vertically.
s. Sample; Height in test jar must be 2 to 2 1/4 inches.

DIRECTIONS FOR TEST NO. 14-59-52

SUBJECT: Loss on Heating of Aroclors

METHOD: 5 Hours at 163°C, ASTM Test D6-30

REFERENCE: Loss on heating of oil and asphaltic compounds ASTM designation D6-30.

Apparatus

Heating Oven: Freas Electric Oven with revolving (5 to 6 rpm) aluminum shelf, Eimer and Amend No. 16402 or equivalent.

Thermometer: "ASTM Loss on Heat, 155 to 170°C". The thermometer is located in front of and level with the revolving shelf in such a manner that it may be read through the double glass window of the oven door.

Heating Dishes: 3 oz. Gill style, flat bottom, seamless ointment box, deep pattern, as made by American Can Co.

Procedure

Weigh on a rough balance about 50 grams (± 1 gm) of the well mixed sample into an accurately tared heating dish. Let stand until dish and contents are at room temperature, then weigh accurately. Place dish in one of the recesses of the revolving shelf of the oven which has been brought to 163°C, then close oven and start rotation of shelf.

Maintain an oven temperature of 163°C (325°F) for 5 hours after the sample has been introduced and the oven has again reached that temperature. Then remove sample from oven, cool and reweigh. From loss in weight, calculate the loss due to volatilization.

Notes

During the 5 hour heating period the temperature should not vary more than 1°C. All tests showing a greater variation in temperature should be rejected.

Under ordinary circumstances a number of samples having about the same degree of volatility may be tested at the same time. Samples varying greatly in volatility should be tested separately. Where extreme accuracy is required not more than one material should be tested at one time and duplicate samples of it should be placed simultaneously in the oven.

This test is exactly that described under ASTM D6-30 which should be consulted for further details of apparatus.

The test is designed to cover loss in weight exclusive of water. If water is present, it should first be removed by suitable methods of dehydration before proceeding with the heat test.

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DIRECTIONS FOR TEST NO. 14-41-54

SUBJECT: Color of Aroclor 5460

METHOD: Lovibond Color of 1:1 Solution in Toluol

Weigh (on a trip balance or equivalent) 50 grams of the Aroclor into a tared 250 cc beaker. Add about 25 cc clear toluol, warm and stir until the Aroclor is dissolved. Place beaker with contents on balance and add toluol until the total content of the beaker is 100 grams (50 grams Aroclor and 50 grams toluol).

Fill a one-inch Lovibond Cell with this solution and obtain Lovibond color readings in the usual way.

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DSW 001477

DIRECTIONS FOR TEST NO. 14-27-33

SUBJECT: Coefficient of Expansion of Aroclors

METHOD: Calculation from Sp. Gr. Data

COEFFICIENT OF EXPANSION IN AROCLORS

Average coefficient of expansion between two given temperatures is calculated from specific gravities as determined by experiment at these temperatures.

Example for Aroclor 1254

Average Coefficient of expansion over range from 25°C to 65°C.

Sp. Gr. at 65/65 = 1.5315 (Determined)

Sp. Gr. at 65/25 = 1.5062 = x (Calculated from above)

Sp. Gr. at 25/25 = 1.5460 = y (Determined)

Formula:

$$\frac{y - x}{x\,(65 - 25)} = .000663 \text{ cc/cc/°C}$$

The formula is derived from $\frac{1/x - 1/y}{1/y\,(65 - 25)}$, which gives the change in volume per unit volume from 25°C to 65°C, divided by the number of degrees in the temperature range. It is not strictly accurate because the coefficient probably changes with the change in temperature but may be considered an approximate average coefficient for the given range.

DSW 001478

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DIRECTIONS FOR TEST NO.______________

SUBJECT: Determination of Freezing Points

METHOD: The methods below are those recommended by Research Dept.

Freezing Point of Diphenyl
(revised method)

Seventy to 100 gm. of Diphenyl are placed in a 100 cc Griffin beaker and heated until the entire mass is melted. The liquid is stirred with an Anschutz (40°-105°C) thermometer. A reading is taken when the first crystals appear. If super-cooling takes place the temperature will rise immediately after the first crystals appear and become constant within one minute. This is the initial freezing point of the sample of Diphenyl and is so recorded.

Freezing Point of Aroclors

For low-freezing materials such as Aroclor 1219, the recommended method is as follows:

Seventy cubic centimeters of Aroclor 1219 are placed in a 100 cc Griffin-type beaker. This beaker is placed in turn in a 150 cc beaker. The 100 cc beaker is supported by its flared rim on the rim of the larger beaker and hangs loosely in the larger beaker. The nested beakers are now placed in an ice sludge.

Initial Freezing Point. The Aroclor is stirred with an Anschutz thermometer (scale 10 to 55°C). The temperature is read every minute and seeds of both 2-chlorodiphenyl and 4-chlorodiphenyl are added every minute until crystals begin to form in the liquid. The temperature at which crystals are first seen to appear is noted. Continue the stirring and temperature readings at one minute intervals until a thin slurry is obtained. In case supercooling takes place (as it often does), a temperature rise will occur after crystals have appeared. In this event, continue the stirring and temperature readings until two or three consecutive readings again show decreasing temperatures.

The highest temperature attained after crystals begin to appear is taken as the "initial freezing point". In case of no supercooling with resultant rise in temperature, the temperature at which crystals first appear is taken as the "initial freezing point".

Solidification Point. The 100 cc beaker is then removed from the larger beaker and placed directly in the ice sludge. Temperature readings are continued until the Aroclor becomes too thick to stir or until the bulb of the thermometer is exposed. The last reliable temperature is recorded as the solidification point.

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Page No. 2 DIRECTIONS FOR TEST NO.________________

SUBJECT: Determination of Freezing Points (cont'd.)

METHOD:________________

Freezing Point. The freezing point of the Aroclor is arbitrarily taken as the average of the "initial freezing point" and the "solidification point". The "initial freezing point" and the "solidification point" should be reported along with the "freezing point".

Check. As a check on the initial freezing point the beaker may be removed from the ice sludge, warmed in the hand, while the Aroclor is stirred with the thermometer, until the temperature is 2° to 4°C. below the initial freezing point. The beaker is then wrapped in a towel and held in the hand. Stirring is continued until the crystals in the Aroclor just melt. The temperature at this point is recorded as the final melting point. If carefully determined, the final melting point serves as a check on the initial freezing point and should not differ by more than a few tenths of a degree at most from the initial freezing point.

If the melting point check is made, the average of the final melting point and initial freezing point is taken as the checked initial freezing point.

Notes

1. If carefully carried out and if the Aroclor is frequently seeded with both 2-chlorodiphenyl and 4-chlorodiphenyl, the determination of initial freezing point should not require checking by the melting point method. However, the Aroclor is very readily super-cooled so that unless great care is taken, it may be cooled several degrees below its initial freezing point before crystallization starts. The result is that when crystallization does set in the temperature rises but the maximum temperature is not attained and observed initial freezing point is therefore low.

2. It is for this reason that the 100 cc beaker is jacketed with a larger beaker during the determination of the initial freezing point. The jacket serves to slow up the rate of cooling and insures a more accurate determination than the method where the 100 cc beaker is placed directly in the ice-sludge for the determination of initial freezing point.

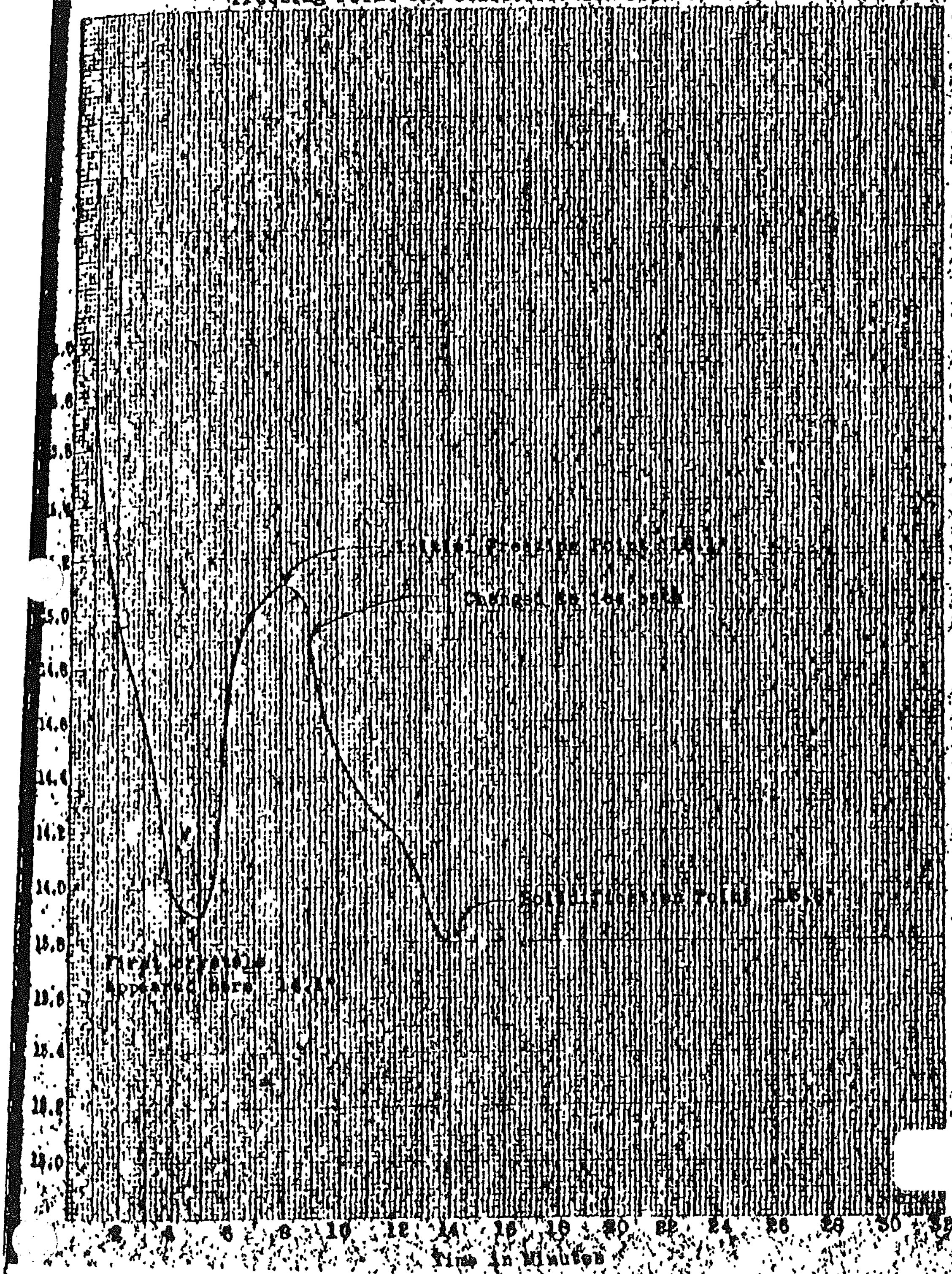
OSW 001480

3. On account of the short exposed mercury column of the Anschutz thermometers, corrections of observed temperatures for emergent stem are not ordinarily required. Under usual conditions of test, this correction is below 0.1°C. If conditions of test are such that the stem correction is large, the appropriate correction should be made and recorded as a corrected temperature. Scale corrections, if any, should always be applied.

4. In the determination, the stirring should be continuous and the temperature readings made at one minute intervals throughout the test. The change from the water jacket to the ice bath should be made quickly without interruption of the one minute readings and the point of change to the ice bath should be indicated on the time temperature curve.

TYPICAL FREEZING POINT CURVE FOR AROCLOR 1219

Freezing Point = 14.45°C (Mean of Initial Freezing Point and Solidification Point.)



DIRECTIONS FOR TEST NO.__________________

SUBJECT: Determination of Benzol Insoluble in Solid Aroclors

METHOD:______________________________

Procedure

Crush about 50 grams of resin. Weigh out 1 gram into a tared 125 cc flask, add 25 cc of benzol and agitate the flask with a circular motion for a few minutes. Then add 25 cc more of benzol, washing down the side of the flask. Allow to stand for 1 hour.

Prepare a #3 Gooch crucible with an asbestos pad in the usual manner and dry to constant weight. Arrange the crucible for filtration by suction.

Filter the solution through the crucible, using slight suction. Use about 50 cc of benzol totransfer the insoluble material left adhering to the sides of the flask and to wash any adhering film of resin from the sides of the crucible. Dry the crucible and flask in an oven at 105-110°C, cool and weigh.

Add to the weight of the insoluble material in the crucible any insoluble matter remaining in the flask. Report insoluble matter as percentage of original weight of resin taken.

Notes

1. The method described above is the one used by the H. H. Robertson Company.

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DSW 001482

DIRECTIONS FOR TEST NO.____________________

SUBJECT: Vaporization Loss at 66°C

METHOD:

The test below is that given to us by the H. H. Robertson Company. They call for the 100 hour loss at 150°F (66°C).

Procedure

Melt slightly more than 50 grams of Aroclor in a suitable container, being careful not to raise the temperature higher than necessary to make the resin fluid. Pour into a tared shallow glass container (100 millimeter Petri dish), cool to room temperature and weigh.

Heat for 100 hours (4 days, 4 hours) at 66°C, in a drying oven provided with a venting outlet for escape of volatile matter. Remove from the oven, cool to room temperature and reweigh. Report loss in weight as percentage of original weight.

Notes

1. On account of the small vaporization loss at 66°C, the weights must be taken very carefully. It is very important in obtaining these close weights that the dish and contents be at atmospheric temperature when the weights are taken.

2. Robertson's first description of this test called for the determination of loss after 50, 100, and 150 hours of drying. From this data, they drew up curves showing loss against time. Their latest procedure calls only for the loss on 100 hours drying.

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DIPHENYL IN CRUDE DIPHENYL OR DIPHENYL STILL BOTTOMS

Procedure

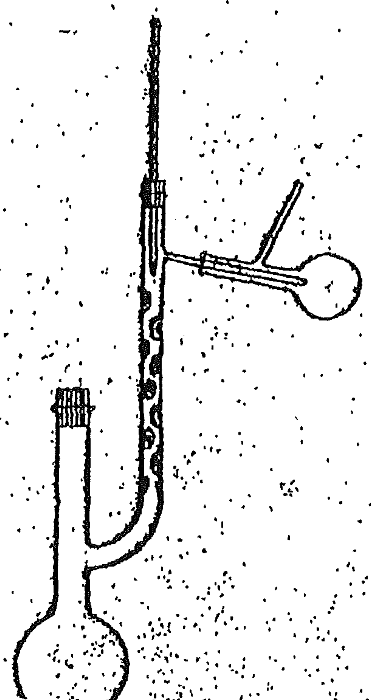
Transfer 100 to 200 grams of the sample to a 250 cc beaker. Weigh beaker and contents on a rough balance to nearest gram. Warm beaker until contents are liquid then pour 100 to 150 grams into a 250 cc distilling flask with 10 inch distilling column attached. Reweigh beaker and contents, thereby obtaining by difference the weight of sample used.

Place a 300°C or 400°C thermometer in the top of the 10 inch distilling column in such a way that the top of the bulb is even with the bottom of the side neck outlet. Distill off the diphenyl and collect in a weighed receiving flask until the thermometer reads 275°C. Weigh the receiving flask again and calculate results.

$$\% \text{ diphenyl} = \frac{\text{wt. diphenyl} \times 100}{\text{wt. of sample}}$$

Pour the residue in the flask while still liquid into a casserole or pan kept for this purpose. Rinse with benzol and allow to dry.

Apparatus



The distilling flask is a 250 cc flask to which a 10 inch column with side outlet near top is attached. The column has indentations to increase surface area. Asbestos paper should be wrapped around the column.

A Meker burner is used in heating the flask. Since a high boiling point must be reached, the transite board or wire gauge on which the flask rests should have a hole nearly as large as the diameter of the flask. The flame may also be applied directly to the flask without the use of any transite board or wire gauge. If necessary, asbestos paper should be placed at the top of the flask.

A 100 cc distilling flask makes a convenient receiver for the distillate.

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DIELECTRIC CONSTANT OF AROCLORS

Definitions

Condenser

Any electrical conductor upon which an electrical charge can be stored is an electrical condenser.

Capacitance (Symbol C)

An electrical condenser can be charged with a certain quantity of static electricity, depending upon its shape and size. This property is known as its capacitance, and the farad is the absolute unit used. For convenience the farad is subdivided into the micro-farad—symbol mF (Greek letter m), and the micromicrofarad—symbol mmF. A farad is defined as the capacitance of a condenser such that one coulomb of electrical energy will produce a potential diff. of 1 volt between its terminals. A micro-farad is .000001 farad and a micromicro-farad is .000000000001 farad. The micromicro-farad is the only unit employed in Aroclor work.

Dielectric Constant

The dielectric constant of any material is defined as the ratio of the capacity of a condenser made up with a dielectric of the material in question to the capacity of the same, having air as the dielectric.

Apparatus

Heating Oven

A Freas-thermo-electric oven, forced air, serial No. 621-61, is used for heating and maintaining the Aroclor at 100°C, the testing temperature.

Holes are drilled through the side of the oven to accomodate the terminal leads.

Standard Condenser, Cs

This condenser is a General Radio Precision Condenser, Type 222-L, Serial No. 1180. It has a fine worm gear vernier which permits the setting of this condenser to be read to a fraction of a micromicro-farad. The scale of the standard condenser is divided into 2500 parts by the vernier employed, and excepting the first three hundred divisions and last one hundred divisions, the capacity changes vary uniformly with change of setting. In other words it is almost a straight line condenser between settings of from 300 to 2400 divisions. Below setting of 300 and above 2400 the line is not straight due to edge effect encountered in engaging or disengaging the plates. The condenser should therefore be used between 300 and 2400 scale divisions (160-1450 mmf).

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The condenser is supplied with its calibration chart showing micromicro-farad equivalence of scale divisions at each 100 divisions. From this chart, the accompanying chart is made, showing the capacitance equivalent for each possible scale setting (Fig. 5-).

Test Condenser, Cx

This condenser is a multipleplate variable air condenser. Two such condensers are made part of the apparatus. One has a capacity of 250 mmf, (General Radio 334-X: isolantite dielectric) and the other a capacity of 100 mmf., and each has its obvious range of usefulness.

The condenser is mounted (locally) in a rectangular metal case, open at the top, and should fit as snugly as possible. The rotor-shaft comes through the front plate of the box and a stuffing box, packed with asbestos twine. The purpose of this box is to contain the liquid sample around the plates of the condenser which should, at the time of testing, be completely submerged in the liquid (Aroclor).

Balancing Condenser, Cs)

This can be any type of air condenser with an effective capacity of 1500 mmf. A General Radio Type 246-L is used. A three plate midget air condenser is used in parallel with this condenser for vernier effect.

Capacity Bridge

A General Radio Type 216 is used. This is the main part of the apparatus and furnishes the arms which make possible the balancing of the system. A resistance box is provided in connection with the bridge and can be used in either arm.

A. C. Source, O.

The source of A.C. is a General Radio pure sine wave audio oscillator, type 213-B, and is fed by a 6 volt storage battery.

Amplifier

The amplifier consists of two stages of audio-frequency amplification, using two U.X. 201-A tubes, two audio transformers, and A, B, and C batteries. It is used for accentuating the null point or balance point.

DSW 001486

Switches, Sw

1. For connecting 6 volt storage battery to audio oscillator.

2. For connecting 6 volt storage battery and "B" battery to filament and plate of amplifier tubes.

3. For placing resistance box in either A or B arm of capacity bridge.

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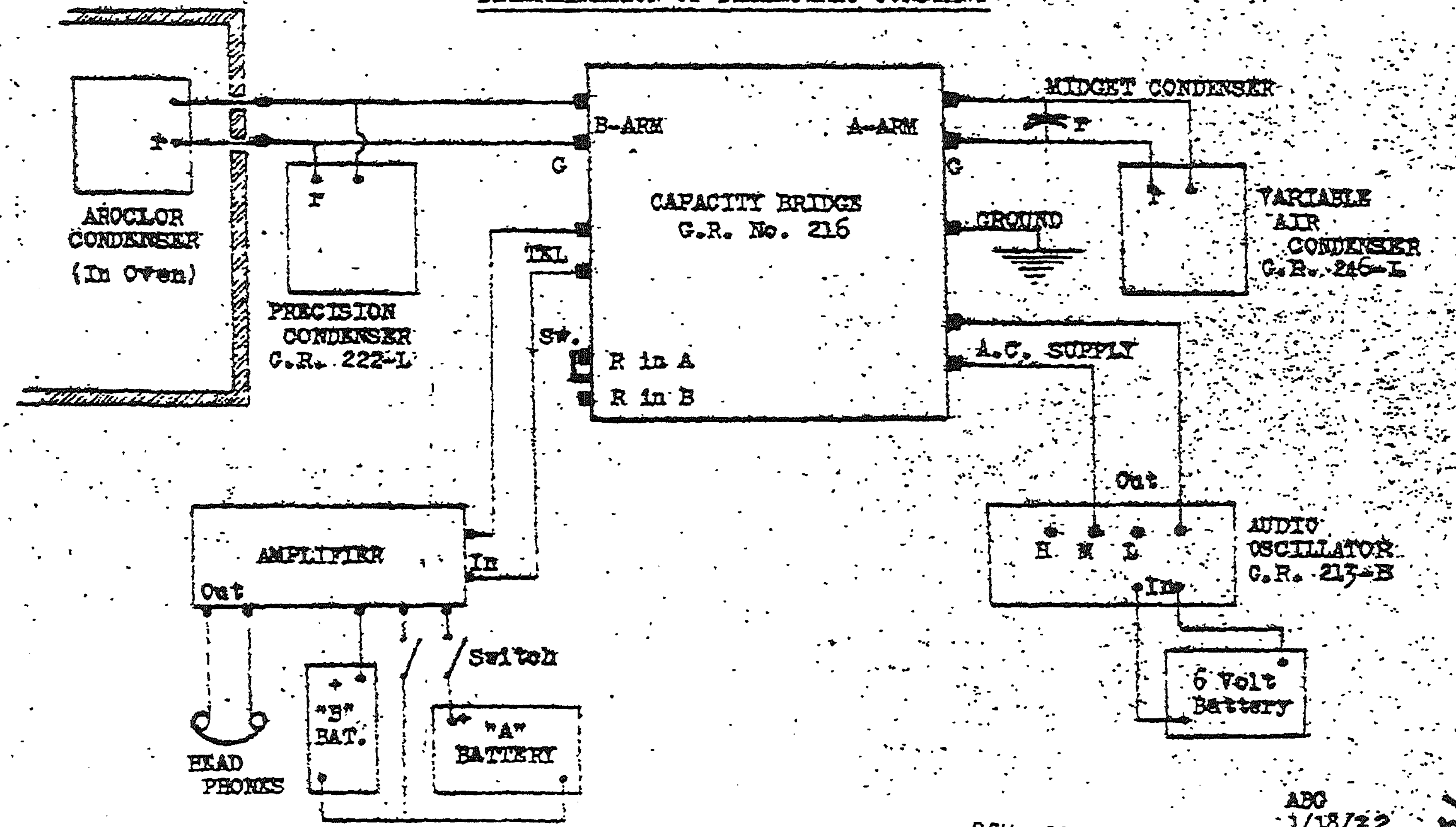
WIRING DIAGRAM FOR APPARATUS
USED IN MEASURING CAPACITY

DETERMINATION OF DIELECTRIC CONSTANT



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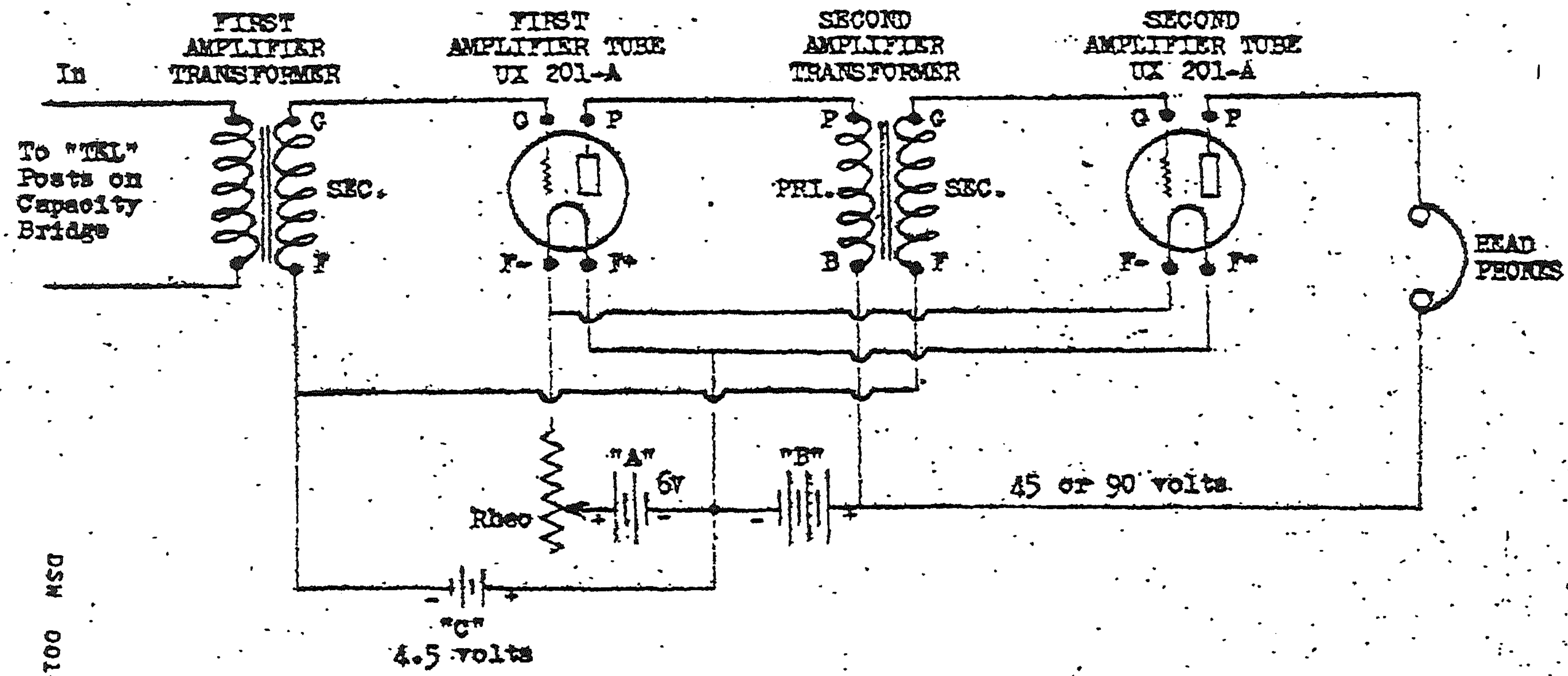

CIRCUIT ARRANGEMENT OF TWO STAGE AMPLIFIER FOR USE WITH CAPACITY BRIDGE

DSW 001488

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Batteries

The two storage batteries used are Ford automobile batteries. The "B" battery is any convenient 45 volt block.

Battery Charger

An A.C.-D.C. rectifier, Westinghouse, style 376793, is used for keeping the two storage batteries charged.

Hook Up

The accompanying wiring diagrams will make the hook-up clear.

Procedure for Measurement

Test Condenser

The difference in capacity between the plates opened and closed must be determined with as high degree of accuracy as possible. In this test air is used as the dielectric medium between the plates of the condenser. This constant will not change appreciably during the life of the condenser, but it is advisable to check it from time to time.

The test condenser is placed in the oven (at 100°C) and allowed to come to temperature. This takes about 20 minutes. The terminals are connected to the leads from the apparatus by means of the clamps provided. The plates of the condenser are then turned to the closed (maximum capacity) position. The rotor-shaft will encounter a stop peg. Care must be taken not to turn the condenser plates too hard against this stop, as it might be bent, thus giving a false reading. Next, the standard condenser is set at exactly 400. The two switches carrying the power supply from the batteries are now closed, and the tuning fork on the oscillator is pricked gently with finger nail to start it vibrating. As this is done, a loud note will be heard in the head-phones. Next, the balancing condenser, Ca, is turned until a minimum noise level is produced. This noise level is further reduced by moving the resistance controls and midget condenser simultaneously until the weakest signal is evident. The system is now said to be balanced, both with respect to the capacity, and resistance in each arm of the bridge. The reading on the standard condenser (400) is recorded.

Next, the test condenser is turned to its minimum (open) position, until the rotor-shaft is pressed against the stop. Now, without touching the balancing condenser or midget condenser, the standard condenser is turned toward a higher setting until another minimum noise level is reached. The fine balance is obtained this time by varying the standard condenser and resistance decades simultaneously. When a balance is reached the reading is recorded from the standard condenser as before. Only these two readings (400 and the last) are necessary for computing the capacity of the difference in position of the plates of the testing condenser. The change in resistance necessary is immaterial. The second reading will be found to be about 150 divisions higher for the 250 mmf condenser and about 60 divisions higher for the 100 mmf condenser.

The entire above procedure is repeated, using the second reading for the next initial setting, etc. until the range from 400 to 2200 scale divisions is covered.

Each pair of readings is then translated into mmf as shown under "Calculations", and the smaller subtracted from the larger to obtain the capacitance difference for minimum and maximum settings of test condenser using air as the dielectric medium. The differences thus found are averaged to give the correct constant for the range covered.

Testing Samples.

The Aroclor is poured into the condenser until it just covered the plates. The condenser is then placed in the oven and allowed to remain there two hours before making the test, so that it will come to 100°C, the testing temperature. Exactly the same procedure is used as in determining the condenser constant, except that only two determinations are taken as checks because the initial balance will be separated from the final balance by well over half the useful scale on the standard condenser. If the first initial reading is 400, the next initial reading should be somewhere near 500, or perhaps 600, depending, of course, on the nature of the substance under examination.

Also, the original setting can be the high one provided the test condenser is at its minimum (open) setting. Even numbers given above are for example purposes and do not have to be used, but are more convenient for calculations.

Calculations

When condensers are connected in parallel, the following formula obtains:

Q (total capacity) = $(q_1 + q_s + q_n)$ sum of each

In this method the total capacity consists of Cs + Cx + Cs. Since Cs stays constant, and Cs can be found, Cx can also be found by subtracting the initial Cs from the Final Cs.

With the initial and final scale reading at hand it is only necessary to consult the chart to obtain the equivalent mmf; the smaller is subtracted from the larger to obtain the difference in mmf.

This difference, when taken with the liquid in the condenser is divided by the constant for testing condenser (diff. with air in the condenser) to obtain the ratio referred to in the definition of D.C., i.e., the dielectric constant of the material in question.

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ADA 000843

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Example

	Scale	mmf (from chart)
Final reading	2194	1294
Initial	400	218
Difference		1076

Constant for testing condenser = 250

Therefore, D.C. $\frac{1076}{250}$ = 4.31

Notes

1. About 750 cc of sample are necessary for a test.

2. A hydrometer is provided for testing the storage batteries from time to time.

3. The batteries should be disconnected from the rest of the set when charging. Failure to do this will cause a fuse to blow out.

4. For D.C. measurement the sample may be heated to 100°C on a hot plate and then poured into the condenser without any loss in accuracy.

5. A cover is provided for the apparatus and should be kept in place whenever the apparatus is not in use.

6. If there is any "cracking" sound in the receivers the tubes should be tested by a reliable Radio shop. All connections and contacts should be kept as free as possible from dirt and grease.

era

Fig. 3 20A

EQUIVALENCE OF SCALE READING IN MMF. FOR STANDARD CALIBRATED CONDENSER : G. R. 221-#1819

400 - 899

Scale Reading	0	1	2	3	4	5	6	7	8	9
40	218.0	218.6	219.2	219.8	220.4	221.0	221.6	222.2	222.8	223.4
41	223.9	224.5	225.1	225.7	226.3	226.9	227.5	228.1	228.7	229.3
42	229.8	230.4	231.0	231.6	232.2	232.8	233.4	234.0	234.6	235.2
43	235.7	236.3	236.9	237.5	238.1	238.7	239.3	239.8	240.4	241.0
44	241.6	242.2	242.8	243.4	244.0	244.6	245.2	245.8	246.3	246.9
45	247.5	248.1	248.7	249.3	249.9	250.5	251.1	251.6	252.2	252.8
46	253.4	254.0	254.6	255.2	255.8	256.4	257.0	257.6	258.1	258.7
47	259.3	259.9	260.5	261.1	261.7	262.3	262.9	263.5	264.0	264.6
48	265.2	265.8	266.4	267.0	267.6	268.2	268.8	269.4	269.9	270.5
49	271.1	271.7	272.3	272.9	273.5	274.1	274.7	275.3	275.8	276.4
50	277.0	277.6	278.2	278.8	279.4	280.0	280.6	281.1	281.7	282.3
51	282.9	283.4	284.0	284.6	285.2	285.7	286.3	286.9	287.5	288.1
52	288.6	289.2	289.8	290.4	291.0	291.5	292.1	292.7	293.3	293.9
53	294.4	295.0	295.6	296.2	296.8	297.3	297.9	298.5	299.1	299.7
54	300.2	300.8	301.4	302.0	302.6	303.1	303.7	304.3	304.9	305.5
55	306.0	306.6	307.2	307.8	308.4	308.9	309.5	310.1	310.7	311.3
56	311.8	312.4	313.0	313.6	314.2	314.7	315.3	315.9	316.5	317.1
57	317.6	318.2	318.8	319.4	320.0	320.5	321.1	321.7	322.3	322.9
58	323.4	324.0	324.6	325.2	325.8	326.3	326.9	327.5	328.1	328.7
59	329.2	329.8	330.4	331.0	331.6	332.1	332.7	333.3	333.9	334.5
60	335.0	335.6	336.2	336.8	337.4	338.0	338.6	339.2	339.8	340.4
61	341.1	341.7	342.3	342.9	343.5	344.1	344.7	345.4	346.0	346.6
62	347.2	347.8	348.4	349.0	349.6	350.2	350.8	351.5	352.1	352.7
63	353.3	353.9	354.5	355.1	355.7	356.3	356.9	357.6	358.2	358.8
64	359.4	360.0	360.6	361.2	361.8	362.4	363.1	363.7	364.3	364.9
65	365.5	366.1	366.7	367.3	367.9	368.6	369.2	369.8	370.4	371.0
66	371.6	372.2	372.8	373.4	374.0	374.6	375.3	375.9	376.5	377.1
67	377.7	378.3	378.9	379.5	380.1	380.7	381.4	382.0	382.6	383.2
68	383.8	384.4	385.0	385.6	386.2	386.8	387.5	388.1	388.7	389.3
69	389.9	390.5	391.1	391.7	392.3	392.9	393.6	394.2	394.8	395.4
70	396.0	396.6	397.2	397.8	398.4	399.0	399.6	400.2	400.8	401.4
71	401.9	402.5	403.1	403.7	404.3	404.9	405.5	406.1	406.7	407.3
72	407.8	408.4	409.0	409.6	410.2	410.8	411.4	412.0	412.6	413.2
73	413.7	414.3	414.9	415.5	416.1	416.7	417.3	417.9	418.5	419.1
74	419.6	420.2	420.8	421.4	422.0	422.6	423.1	423.7	424.3	424.9
75	425.5	426.1	426.7	427.3	427.9	428.5	429.1	429.7	430.3	430.9
76	431.4	432.0	432.6	433.2	433.8	434.4	435.0	435.6	436.2	436.7
77	437.3	437.9	438.5	439.1	439.7	440.3	440.9	441.5	442.1	442.7
78	443.2	443.8	444.4	445.0	445.6	446.2	446.8	447.4	448.0	448.6
79	449.1	449.7	450.3	450.9	451.5	452.1	452.7	453.3	453.9	454.5
80	455.0	455.6	456.2	456.8	457.4	458.0	458.6	459.2	459.8	460.4
81	461.0	461.6	462.2	462.8	463.4	464.0	464.6	465.2	465.8	466.4
82	467.0	467.6	468.2	468.8	469.4	470.0	470.6	471.2	471.8	472.4
83	473.0	473.6	474.2	474.8	475.4	476.0	476.6	477.2	477.8	478.4
84	479.0	479.6	480.2	480.8	481.4	482.0	482.6	483.2	483.8	484.4
85	485.0	485.6	486.2	486.8	487.4	488.0	488.6	489.2	489.8	490.4
86	491.0	491.6	492.2	492.8	493.4	494.0	494.6	495.2	495.8	496.4
87	497.0	497.6	498.2	498.8	499.4	500.0	500.6	501.2	501.8	502.4
88	503.0	503.6	504.2	504.8	505.4	506.0	506.6	507.2	507.8	508.4
89	509.0	509.6	510.2	510.8	511.4	512.0	512.6	513.2	513.8	514.4

DSW 001492

ADA 000845

205

EQUIVALENCE OF SCALE READING IN MMF. FOR STANDARD CALIBRATED CONDENSER : C.R. 221 - #1019

900 - 1399

Scale Reading	0	1	2	3	4	5	6	7	8	9
90	515.0	515.6	516.2	516.8	517.4	518.0	518.6	519.2	519.8	520.4
91	521.0	521.6	522.2	522.8	523.4	524.0	524.6	525.2	525.8	526.4
92	527.0	527.6	528.2	528.8	529.4	530.0	530.6	531.2	531.8	532.4
93	533.0	533.6	534.2	534.8	535.4	536.0	536.6	537.2	537.8	538.4
94	539.0	539.6	540.2	540.8	541.4	542.0	542.6	543.2	543.8	544.4
95	545.0	545.6	546.2	546.8	547.4	548.0	548.6	549.2	549.8	550.4
96	551.0	551.6	552.2	552.8	553.4	554.0	554.6	555.2	555.8	556.4
97	557.0	557.6	558.2	558.8	559.4	560.0	560.6	561.2	561.8	562.4
98	563.0	563.6	564.2	564.8	565.4	566.0	566.6	567.2	567.8	568.4
99	569.0	569.6	570.2	570.8	571.4	572.0	572.6	573.2	573.8	574.4
100	575.0	575.6	576.2	576.8	577.4	578.0	578.6	579.2	579.8	580.4
101	581.0	581.6	582.2	582.8	583.4	584.0	584.6	585.2	585.8	586.4
102	587.0	587.6	588.2	588.8	589.4	590.0	590.6	591.2	591.8	592.4
103	593.0	593.6	594.2	594.8	595.4	596.0	596.6	597.2	597.8	598.4
104	599.0	599.6	600.2	600.8	601.4	602.0	602.6	603.2	603.8	604.4
105	605.0	605.6	606.2	606.8	607.4	608.0	608.6	609.2	609.8	610.4
106	611.0	611.6	612.2	612.8	613.4	614.0	614.6	615.2	615.8	616.4
107	617.0	617.6	618.2	618.8	619.4	620.0	620.6	621.2	621.8	622.4
108	623.0	623.6	624.2	624.8	625.4	626.0	626.6	627.2	627.8	628.4
109	629.0	629.6	630.2	630.8	631.4	632.0	632.6	633.2	633.8	634.4
110	635.0	635.6	636.2	636.8	637.4	638.0	638.6	639.2	639.8	640.4
111	641.0	641.6	642.2	642.8	643.4	644.0	644.6	645.2	645.8	646.4
112	647.0	647.6	648.2	648.8	649.4	650.0	650.6	651.2	651.8	652.4
113	653.0	653.6	654.2	654.8	655.4	656.0	656.6	657.2	657.8	658.4
114	659.0	659.6	660.2	660.8	661.4	662.0	662.6	663.2	663.8	664.4
115	665.0	665.6	666.2	666.8	667.4	668.0	668.6	669.2	669.8	670.4
116	671.0	671.6	672.2	672.8	673.4	674.0	674.6	675.2	675.8	676.4
117	677.0	677.6	678.2	678.8	679.4	680.0	680.6	681.2	681.8	682.4
118	683.0	683.6	684.2	684.8	685.4	686.0	686.6	687.2	687.8	688.4
119	689.0	689.6	690.2	690.8	691.4	692.0	692.6	693.2	693.8	694.4
120	695.0	695.6	696.2	696.8	697.4	698.0	698.6	699.2	699.8	700.4
121	701.0	701.6	702.2	702.8	703.4	704.0	704.6	705.2	705.8	706.4
122	707.0	707.6	708.2	708.8	709.4	710.0	710.6	711.2	711.8	712.4
123	713.0	713.6	714.2	714.8	715.4	716.0	716.6	717.2	717.8	718.4
124	719.0	719.6	720.2	720.8	721.4	722.0	722.6	723.2	723.8	724.4
125	725.0	725.6	726.2	726.8	727.4	728.0	728.6	729.2	729.8	730.4
126	731.0	731.6	732.2	732.8	733.4	734.0	734.6	735.2	735.8	736.4
127	737.0	737.6	738.2	738.8	739.4	740.0	740.6	741.2	741.8	742.4
128	743.0	743.6	744.2	744.8	745.4	746.0	746.6	747.2	747.8	748.4
129	749.0	749.6	750.2	750.8	751.4	752.0	752.6	753.2	753.8	754.4
130	755.0	755.6	756.2	756.8	757.4	758.0	758.6	759.2	759.8	760.4
131	761.0	761.6	762.2	762.8	763.4	764.0	764.6	765.2	765.8	766.4
132	767.0	767.6	768.2	768.8	769.4	770.0	770.6	771.2	771.8	772.4
133	773.0	773.6	774.2	774.8	775.4	776.0	776.6	777.2	777.8	778.4
134	779.0	779.6	780.2	780.8	781.4	782.0	782.6	783.2	783.8	784.4
135	785.0	785.6	786.2	786.8	787.4	788.0	788.6	789.2	789.8	790.4
136	791.0	791.6	792.2	792.8	793.4	794.0	794.6	795.2	795.8	796.4
137	797.0	797.6	798.2	798.8	799.4	800.0	800.6	801.2	801.8	802.4
138	803.0	803.6	804.2	804.8	805.4	806.0	806.6	807.2	807.8	808.4
139	809.0	809.6	810.2	810.8	811.4	812.0	812.6	813.2	813.8	814.4

DSW 001493

FIG. 206

EQUIVALENCE OF SCALE READING IN MMF. FOR STANDARD CALIBRATED CONDENSER I.O.R. 771 - 71019

1400 - 1899

	0	1	2	3	4	5	6	7	8	9
140	815.0	815.6	816.2	816.8	817.4	818.0	818.6	819.2	819.8	820.4
141	821.0	821.6	822.2	822.8	823.4	824.0	824.6	825.2	825.8	826.4
142	827.0	827.6	828.2	828.8	829.4	830.0	830.6	831.2	831.8	832.4
143	833.0	833.6	834.2	834.8	835.4	836.0	836.6	837.2	837.8	838.4
144	839.0	839.6	840.2	840.8	841.4	842.0	842.6	843.2	843.8	844.4
145	845.0	[illegible]	846.2	846.8	847.4	848.0	[illegible]	849.2	849.8	850.4
146	851.0	[illegible]	[illegible]	[illegible]	[illegible]	854.0	[illegible]	[illegible]	[illegible]	[illegible]
147	857.0	857.6	[illegible]	[illegible]	859.4	860.0	860.6	861.2	[illegible]	[illegible]
148	863.0	863.6	864.2	864.8	[illegible]	866.0	866.6	867.2	867.8	868.4
149	869.0	869.6	870.2	870.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	[illegible]	[illegible]	[illegible]	876.8	[illegible]	878.0	[illegible]	[illegible]	[illegible]	[illegible]
151	881.0	[illegible]	[illegible]	[illegible]	[illegible]	884.0	884.6	[illegible]	[illegible]	[illegible]
152	887.0	887.6	[illegible]	888.8	889.4	890.0	890.6	891.2	891.8	[illegible]
153	893.0	893.6	[illegible]	[illegible]	[illegible]	896.0	[illegible]	897.2	897.8	[illegible]
154	[illegible]	[illegible]	900.2	900.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
155	905.0	[illegible]	906.2	906.8	[illegible]	908.0	908.6	[illegible]	[illegible]	[illegible]
156	911.0	[illegible]	[illegible]	912.8	[illegible]	914.0	[illegible]	[illegible]	[illegible]	[illegible]
157	917.0	[illegible]	918.2	918.8	[illegible]	920.0	[illegible]	[illegible]	[illegible]	[illegible]
158	923.0	[illegible]	924.2	924.8	[illegible]	926.0	[illegible]	[illegible]	[illegible]	[illegible]
159	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
160	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
161	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	941.0	[illegible]	[illegible]	[illegible]	[illegible]
162	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
163	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
164	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
165	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
166	971.0	971.6	972.2	[illegible]	[illegible]	974.0	[illegible]	[illegible]	[illegible]	[illegible]
167	977.0	977.6	[illegible]	[illegible]	[illegible]	980.0	[illegible]	[illegible]	[illegible]	[illegible]
168	983.0	983.6	[illegible]	[illegible]	[illegible]	986.0	[illegible]	987.2	987.8	[illegible]
169	989.0	989.6	990.2	990.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
170	[illegible]	[illegible]	996.2	996.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
171	1001.0	1001.6	1002.2	1002.8	[illegible]	1004.0	1004.6	1005.2	1005.8	[illegible]
172	1007.0	1007.6	1008.2	1008.8	1009.4	1010.0	1010.6	1011.2	1011.8	1012.4
173	1013.0	1013.6	1014.2	1014.8	1015.4	1016.0	1016.6	1017.2	1017.8	1018.4
174	1019.0	1019.6	1020.2	1020.8	1021.4	1022.0	1022.6	1023.2	1023.8	1024.4
175	1025.0	1025.6	1026.2	1026.8	1027.4	1028.0	1028.6	1029.2	1029.8	1030.4
176	1031.0	1031.6	1032.2	1032.8	1033.4	1034.0	1034.6	1035.2	1035.8	1036.4
177	1037.0	1037.6	1038.2	1038.8	1039.4	1040.0	1040.6	1041.2	1041.8	1042.4
178	1043.0	1043.6	1044.2	1044.8	1045.4	1046.0	1046.6	1047.2	1047.8	1048.4
179	1049.0	1049.6	1050.2	1050.8	1051.4	1052.0	1052.6	1053.2	1053.8	1054.4
180	1055.0	1055.6	1056.2	1056.8	1057.4	1058.0	1058.6	1059.2	1059.8	1060.4
181	1061.0	1061.6	1062.2	1062.8	1063.4	1064.0	1064.6	1065.2	1065.8	1066.4
182	1067.0	1067.6	1068.2	1068.8	1069.4	1070.0	1070.6	1071.2	1071.8	1072.4
183	1073.0	1073.6	1074.2	1074.8	1075.4	1076.0	1076.6	1077.2	1077.8	1078.4
184	1079.0	1079.6	1080.2	1080.8	1081.4	1082.0	1082.6	1083.2	1083.8	1084.4
185	1085.0	1085.6	1086.2	1086.8	1087.4	1088.0	1088.6	1089.2	1089.8	1090.4
186	1091.0	1091.6	1092.2	1092.8	1093.4	1094.0	1094.6	1095.2	1095.8	1096.4
187	1097.0	1097.6	1098.2	1098.8	1099.4	1100.0	1100.6	1101.2	1101.8	1102.4
188	1103.0	1103.6	1104.2	1104.8	1105.4	1106.0	1106.6	1107.2	1107.8	1108.4
189	1109.0	1109.6	1110.2	1110.8	1111.4	1112.0	1112.6	1113.2	1113.8	1114.4

DSW 001494

ADA 000847

Fig. 3

204

EQUIVALENCE OF SCALE READING IN MMF. FOR STANDARD CALIBRATED CONDENSER : G.R. 221 - #1819

1900 - 2200

Scale Reading	0	1	2	3	4	5	6	7	8	9
190	1116.0	1116.6	1117.2	1117.8	1118.4	1119.0	1119.6	1120.2	1120.8	1121.4
191	1122.0	1122.6	1123.2	1123.8	1124.4	1125.0	1125.6	1126.2	1126.8	1127.4
192	1128.0	1128.6	1129.2	1129.8	1130.4	1131.0	1131.6	1132.2	1132.8	1133.4
193	1134.0	1134.6	1135.2	1135.8	1136.4	1137.0	1137.6	1138.2	1138.8	1139.4
194	1140.0	1140.6	1141.2	1141.8	1142.4	1143.0	1143.6	1144.2	1144.8	1145.4
195	1146.0	1146.6	1147.2	1147.8	1148.4	1149.0	1149.6	1150.2	1150.8	1151.4
196	1152.0	1152.6	1153.2	1153.8	1154.4	1155.0	1155.6	1156.2	1156.8	1157.4
197	1158.0	1158.6	1159.2	1159.8	1160.4	1161.0	1161.6	1162.2	1162.8	1163.4
198	1164.0	1164.6	1165.2	1165.8	1166.4	1167.0	1167.6	1168.2	1168.8	1169.4
199	1170.0	1170.6	1171.2	1171.8	1172.4	1173.0	1173.6	1174.2	1174.8	1175.4
200	1176.0	1176.6	1177.2	1177.8	1178.4	1179.0	1179.6	1180.2	1180.9	1181.5
201	1182.1	1182.7	1183.3	1183.9	1184.5	1185.1	1185.8	1186.4	1187.0	1187.6
202	1188.2	1188.8	1189.4	1190.0	1190.6	1191.2	1191.9	1192.5	1193.1	1193.7
203	1194.3	1194.9	1195.5	1196.1	1196.7	1197.4	1198.0	1198.6	1199.2	1199.8
204	1200.4	1201.0	1201.6	1202.2	1202.8	1203.5	1204.1	1204.7	1205.3	1205.9
205	1206.5	1207.1	1207.7	1208.3	1208.9	1209.6	1210.2	1210.8	1211.4	1212.0
206	1212.6	1213.2	1213.8	1214.4	1215.0	1215.7	1216.3	1216.9	1217.5	1218.1
207	1218.7	1219.3	1219.9	1220.5	1221.1	1221.8	1222.4	1223.0	1223.6	1224.2
208	1224.8	1225.4	1226.0	1226.6	1227.2	1227.9	1228.5	1229.1	1229.7	1230.3
209	1230.9	1231.5	1232.1	1232.7	1233.3	1234.0	1234.6	1235.2	1235.8	1236.4
210	1237.0	1237.6	1238.2	1238.8	1239.4	1240.0	1240.6	1241.2	1241.8	1242.4
211	1243.0	1243.6	1244.2	1244.8	1245.4	1246.0	1246.6	1247.2	1247.8	1248.4
212	1249.0	1249.6	1250.2	1250.8	1251.4	1252.0	1252.6	1253.2	1253.8	1254.4
213	1255.0	1255.6	1256.2	1256.8	1257.4	1258.0	1258.6	1259.2	1259.8	1260.4
214	1261.0	1261.6	1262.2	1262.8	1263.4	1264.0	1264.6	1265.2	1265.8	1266.4
215	1267.0	1267.6	1268.2	1268.8	1269.4	1270.0	1270.6	1271.2	1271.8	1272.4
216	1273.0	1273.6	1274.2	1274.8	1275.4	1276.0	1276.6	1277.2	1277.8	1278.4
217	1279.0	1279.6	1280.2	1280.8	1281.4	1282.0	1282.6	1283.2	1283.8	1284.4
218	1285.0	1285.6	1286.2	1286.8	1287.4	1288.0	1288.6	1289.2	1289.8	1290.4
219	1291.0	1291.6	1292.2	1292.8	1293.4	1294.0	1294.6	1295.2	1295.8	1296.4
220	1297.0									

DSW 001495

ADA 000848

POWER FACTOR

Definitions

When condensers are used on A.C. circuits there is an energy loss in the dielectric. This loss arises through the repeated cycle of changes of electric flux through which the dielectric is taken by applied alternating voltage. This loss increases with the frequency; hence, the frequency has to be reported with the result. It also varies with the temperature of the condenser, and hence this also must be reported as part of the result.

The "Power Factor" is the ratio of all energy losses in a dielectric to the "apparent power" in the dielectric. It is usually expressed in percentage.

In the test to be described the standard temperature used is 100°C, and the standard frequency is 1000 cycles per second. Hence, it is not necessary to include these habitual constants in reporting results.

Power Factor Determination

Inasmuch as the same equipment is used for measuring power factor as dielectric constant, the method will be outlined, making reference to that method.

Apparatus

The apparatus is the same as that used in dielectric constant measurement except for the testing cell. A drawing of the cell is attached (Figure 4). It consists of 2 cylinders of the dimensions shown and is contained in an 800 cc Griffin Beaker. In the assembly the beaker containing the cell is placed in the oven in the same place as the dielectric constant condenser, and is connected to the same leads. Due to the fact that the test is affected appreciably by small amounts of stray currents, the 800 cc beaker is insulated from the iron floor by means of a glass "Y" stilt, upon which it stands, and the inner electrode is suspended from a ring stand by means of a glass stirring rod, passed through a cork, and "hooked" at the bottom. The wire loop passing through the vertical rod of the inner electrode is hung on this glass hook.

DSW 001496

Method of measurement

To measure the Power Factor of an Aroclor, the test cell is filled about two thirds full of the liquid, and the leads connected, as in dielectric constant measurement. The standard condenser is set on about 1600 scale reading and the system brought to balance as directed in the dielectric constant procedure. The Cs reading and also the resistance reading are noted. The one of the leads is disconnected outside the oven, care being taken to move the two ends as little as possible from their connected position, and the system again brought to balance by manipulating only the standard condenser and resistance decades. The new readings Cs_1 and R_1 are noted.

ADA 000849

WATER_PCB-SD0000046016

Calculations

The equation for P.F. as obtained by our instruments is:

$$P.F. = \frac{(R_1 - R_2)(Cs_2)^2 \times 2\pi f. \times 10^{-10}}{Cs_2 - Cs}$$

R_2 = Resistance reading corresponding to Cs_2.
R_1 = Resistance reading corresponding to Cs_1.
Cs_2 = Largest reading (in mmf) on std. condenser.
Cs = Smallest reading (in mmf) on std. condenser.
f = Frequency in cycles per second.

Example

Cs_1 = 1600 scale reading = 935.0 mmf.
Cs_2 = 1981 scale reading = 1164.6 mmf.
R_1 = 180 ohms (reading on decades)
R_2 = 105 ohms (reading on decades)
f = 1000 c.p.s.

$$P.F. = \frac{(180-105)(1164.6)^2 \times 6.28 \times 1000}{1164.6 - 935}$$

$$= \frac{75 \times 1,354,000 \times 62,800 \times 10^{-10}}{229.6} = 2.78\%$$

(slide rule)

(1) The inner electrode should be suspended as nearly as possible in the center of the outer electrode.

(2) If $R_1 - R_2$ is negative, this means that the power factor is so low that it is within the lower limit of measurement (.02%) of the apparatus. In this case it is reported as 0.

(3) The same general notes under dielectric constant also apply to power factor.

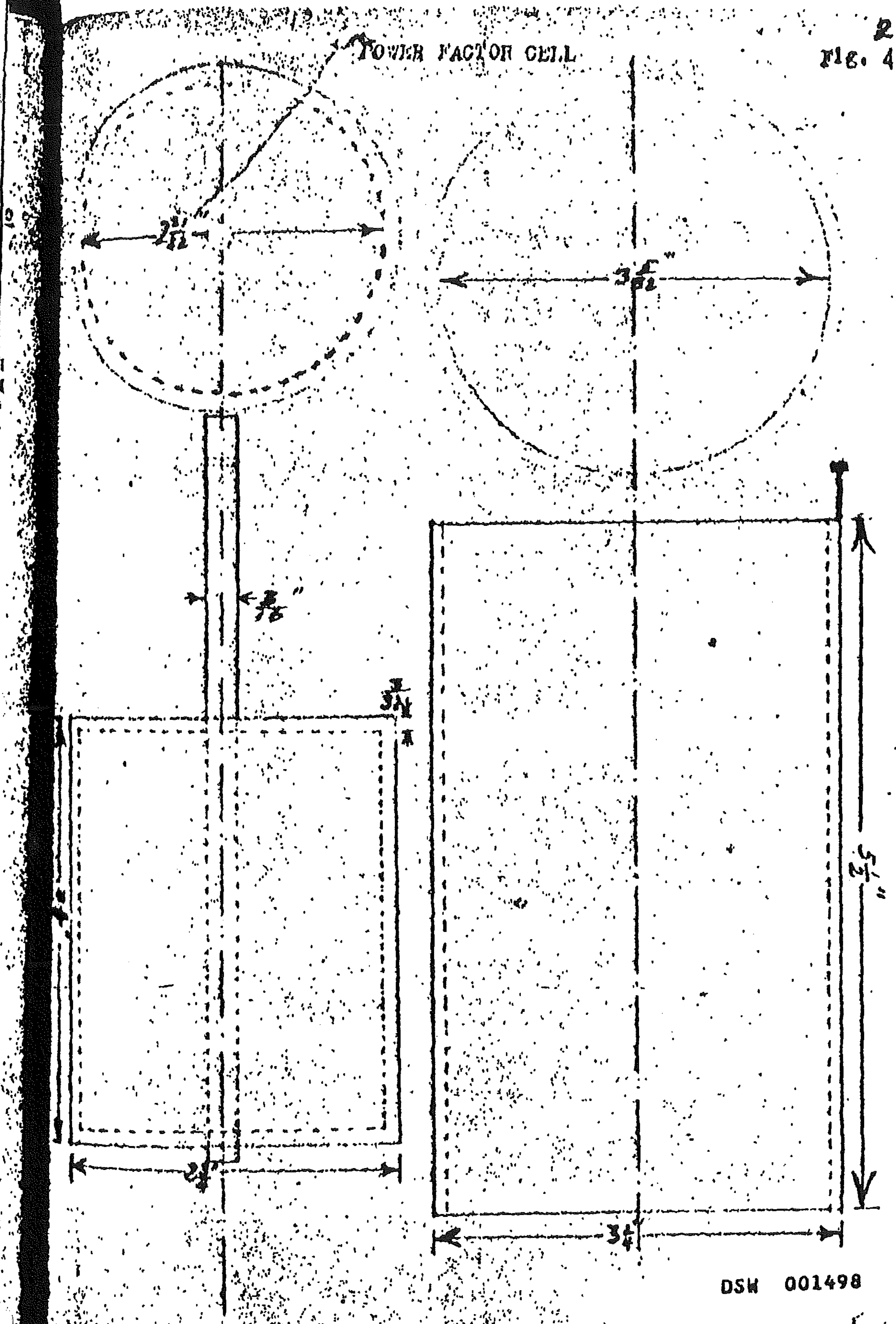
ers

DSW 001497

ADA 000850

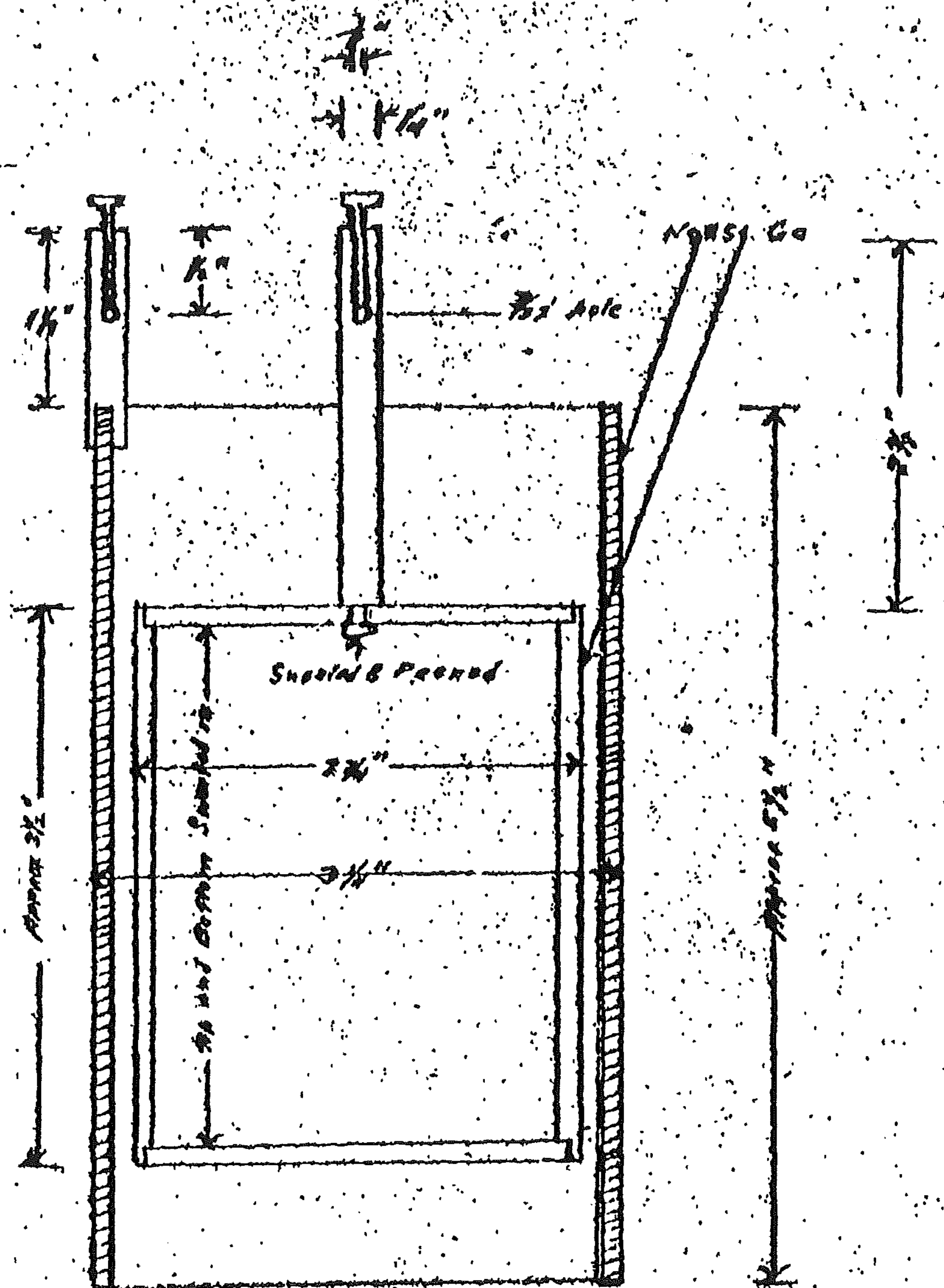
210

Fig. 4



DSW 001498

ADA 000851



POWER FACTOR CELL.
NICKEL METAL USED THROUGHOUT

DSW 001499

ADA 000852

212

SWANN CHEMICAL COMPANY

INSPECTION DEPARTMENT

METHOD FOR THE DETERMINATION OF ELECTRICAL RESISTIVITY OF AROCLORS

REVISED, JUNE 22, 1935

DSW 001500

RESISTIVITY OF AROCLORS

Definitions

Resistance (symbol R). Obstruction to electric flow. The ratio of voltage (E) to current (I) in a conductor or closed circuit. (R = E/I. Ohm's Law). The practical unit of resistance is the ohm.

Electrical Resistivities. The current which flows between two conductors insulated from each other by a dielectric is made up of two components (1) that which flows through the dielectric itself and (2) that which flows through a surface film of moisture or other semiconducting material (oil, dust, or foreign matter). These components are designated respectively as "volume resistivity" and as "surface resistivity".

Volume Resistivity. Symbol p (Greek letter "rho".) Also called specific resistance. Defined as the resistance between two opposite faces of a unit cube of the substance. p = RA/L where A is cross-sectional area and L is length of the current path through the substance. The practical unit of resistivity is the ohm-centimeter (ohm-cm.). The resistivity of Aroclors is reported in multiples of 10^9 ohm-cm.

A volume resistivity of 736 x 10^9 ohm-cm is equivalent to saying that the resistance offered by the substance between two opposed parallel faces of 1 sq. cm. each, placed 1 cm apart is 736 x 10^9 ohms. Following the practice of the General Electric Company, resistivity is measured with the substance under test (Aroclor) at 100°C. "Resistivity" as applied to Aroclors always refers to volume resistivity.

Surface resistivity (symbol S, Greek letter "Sigma") is defined as the resistance between two opposite edges of a square surface film. The practical unit is the ohm-cm (between opposite edges of a film 1 cm. square) S = Rb/l where R is resistance of a rectangle of film of length l and breadth b.

Measurements of surface resistivity are applied to solid dielectrics rather than to liquid. For most materials the surface resistivity is much lower than the volume resistivity. Atmospheric humidity conditions at time of measuring may frequently greatly alter the surface resistivity.

ers

MEASUREMENT OF RESISTIVITY OF AROCLORS AND LIQUID DIELECTRICS

Outline of Method Using General Radio Type 544-A Megohm Meter

The megohm meter is essentially a calibrated bridge with a vacuum tube volt meter as the null indicator. A blueprint is attached showing the circuit diagram and the brief instructions furnished by the manufacturer for the operation of the megohm meter. Resistivity is obtained by matching the voltage across the P resistor (see blueprint) with that across the A resistor. The resistance in megohms is read directly from the dial controlling the log arithmetically tapered rheostat B. This reading in megohms divided by 0.752 gives the specific resistance in ohms x 10^9/cu. cm. The measurements are made with the dielectric under test at 100°C. The apparatus is suitable in the range 10,000 ohms-10,000 megohm/cu. cm. About one pint of sample is required.

Apparatus

Batteries: Two 45 volt Radio B Batteries, series connected are used. Two 1.5 volt dry cells, series connected. The batteries should be tested from time to time by means of a pocket voltmeter for radio batteries and those batteries showing weak cells (more than a few volts below rating) should be replaced.

Batteries are used for a source of voltage to obtain the desired steadiness since otherwise the normal leakage current through the dielectric would be masked by the larger currents flowing into and out of the test electrodes with each pulsation or irregularity of the voltage.

Test Terminals or Electrodes: Brass nickel-plated cylinders made according to drawing No. M-1559663, mean area 191 sq. cm., spaced .254 cm. apart. Copies of this drawing are attached. These terminals should be replated as required to maintain an even surface finish. The electrode constant (Area/Length) for these terminals is 752. See "Calibrations of Electrodes" for derivation of this constant.

These test terminals may also be purchased from the General Electric Company. The electrodes are placed on 5" diameter pyrex glass plate resting on the bottom of a 600 Ml pyrex beaker to complete the electrode assembly. The cylinders are fully immersed in the liquid dielectric under test.

DSW 001502

Heating Oven: A Freas thermo-electric oven, forced air, 60 to 180°C, size 18" x 18", serial No. 621-61 is used for heating the Aroclor and test electrodes to 100°C at which temperature the resistivity is measured.

Two holes are cut through the back of the oven through which the flexible wires to the electrodes are introduced. Glass tubing is used at the holes where the insulated wires come through. Inside the oven, the wires are covered with porcelain beads. The ends of the wires are joined to screw clips to which the wires from the test electrodes may be joined when ready for measurements.

Procedure for Resistivity Measurement

Preparation of Electrodes: Before use, the electrodes, glass plate, and beaker must be very carefully cleaned and dried. Clean first with small brush and benzene to remove grime. Wash with hot distilled water, dry and wash in carbon tetrachloride and dry at 100°C for at least one hour. For cleaning after use in Aroclor, wash with benzene to remove all Aroclor. Then wash thoroughly with clean carbon-tetrachloride and dry at 100°C for at least 15 minutes. Do not touch with the fingers any surfaces of the electrodes, glass plate, or beaker (which are to come in contact with the liquid to be tested) after the last washing.

Filling of Electrodes: Heat the sample to be tested to 100°C ± 5°C, on a hot plate. Pour the substance to be tested (Aroclor) into the dried electrode assembly until the liquid entirely covers the cylindrical surfaces of the electrode with 1/8 to 1/2" excess. Care must be used to make sure that the lip of the container, from which the liquid is poured, is clean. Tilt the beaker in such manner that all air bubbles in the Aroclor will rise to the surface. Place the beaker (containing the electrodes and Aroclor) in the forced draft oven which is maintained at 100°C ± 5°. Measurements are made after about 15 minutes heating.

Reading: The attached page gives the method for making the readings with the General Radio Type 544-A Megohm Meter.

Notes

1. The electrodes are centered as closely as can be judged with the eye. More exact centering is not necessary since the average space between surfaces remains constant. After centering, care must be taken that the electrode position is not further disturbed by jarring or by vibration from oven motor.

2. Resistivities of Aroclors are usually measured at the temperature of 100°C specified by the General Electric Company for testing Aroclor 1254. The usual effect of temperature on resistivity is that if the dielectric contains moisture, the application of heat will reduce the moisture content and simultaneously increase the resistivity. In the case of a thoroughly dry dielectric, however, increase of temperature usually has the reverse effect. Prolonged heating of a dielectric, if in excess of safe or conservative working temperature, is injurious and tends to hasten the breakdown of the material by decomposition or chemical change. The General Electric Company specified that Aroclor 1254 after heating at 100°C for 96 hours shall show no loss in resistivity.

3. The resistivity of Aroclors is lowered by the presence of polar impurities such as ferric chloride or hydrochloric acid. These polar impurities affect the resistivity to a greater extent in the more liquid Aroclors than in the viscous Aroclors (Reference: H. B. Glass).

DSW 001503

ADA 000856

WATER_PCB-SD0000046023

4. The resistivity of a dielectric with alternating currents is usually less than with continuous currents, and decreases progressively as a rule with increase in frequency, owing to dielectric energy losses.

5. For the measurement of resistivity by the above method about 1 pint (470 ml) of sample is required.

6. Duplicate measurements on one sample should check within about 50%.

ers

RESISTIVITY OF VARIOUS DIELECTRICS

Reference: Standard Hand-book for Electrical Engineers.
Coursey; Electrical Condensers.

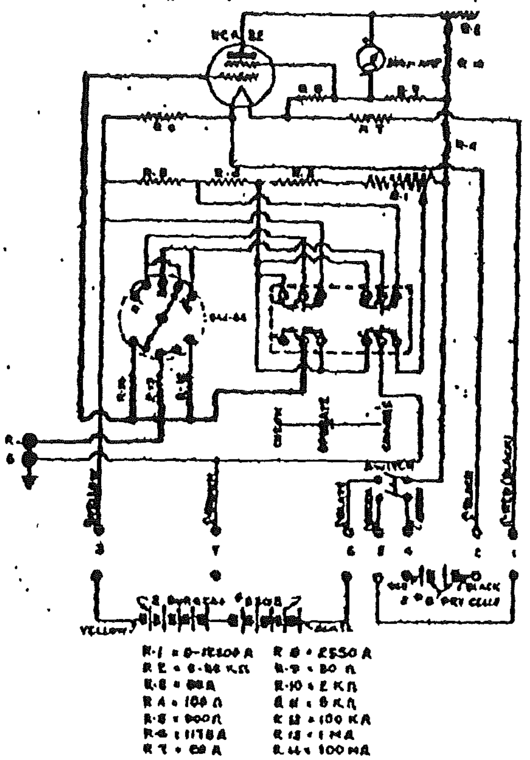
Dielectric	Resistivity in ohm-cm.
SOLIDS	
Paraffin	1 to 10000 x 10^{15}
Fused Quartz (ordinary temp.)	0.1 to 10000 x 10^{15}
Mica, Madras or Bengal	10 to 150 x 10^{12}
Mica, Canada	0.44 to 22 x 10^{12}
Glass (ordinary temperature)	10 to 10000 x 10^{12}
Rubber	100 x 10000 x 10^{12}
Bakelite	0.5 to 3 x 10^{12}
Unglazed Porcelain (ordinary temperature)	100 to 1000 x 10^{12}
Marble	0.1 to 10 x 10^{9}
LIQUIDS	
Transformer Oil A	490 x 10^{9}
Transformer Oil B	5100 x 10^{9}
Pratts Astral (kerosene)	470000 x 10^{9}
Castor Oil	50000 x 10^{9}
Ethyl Alcohol	3.3 x 10^{5}
Linseed Oil	50 x 10^{9}
Olive Oil	1000 x 10^{9}
Water, Distilled	70 x 10^{9}
Aroclor 1254 (100°C, 500 V.)	100 to 800 x 10^{9}

DSW 001505

ers

ADA 000858

TYPE 544-A MEGOHM METER



MEASUREMENTS IN THE ABSENCE OF CAPACITANCE AND EXTRANEOUS POTENTIALS

1. Install batteries or power-supply unit and tubes as described in accompanying instruction book, page 2.
2. Throw ON-OFF switch to ON and wait about two minutes for tube to t up before beginning measurements.
3. Connect unknown resistor to R_X terminals making the "high-poten-l" wire as short as possible. Two or three inches is satisfactory.
4. Set control knob (CHECK-OPERATE-CHARGE) to CHECK.
5. Turn ZERO ADJUST knob until galvanometer reads zero. If the ge of adjustment is insufficient, excessive d-c or a-c voltage pickup probably present in the resistor. If the zero drifts steadily in the e direction, the presence of capacitance in the unknown resistor is icated. In either case, refer to the procedure given in the instruc-n book, page 4.
6. Turn control knob to OPERATE and adjust MULTIPLIER switch and OHMS dial for zero reading of galvanometer.
7. Read resistance in megohms from MEGOHMS dial and the MULTIPLIER tch.
8. For more accurate determinations recheck the galvanometer zero in 4 and 5 above.

DSW 001506

ADA 000859

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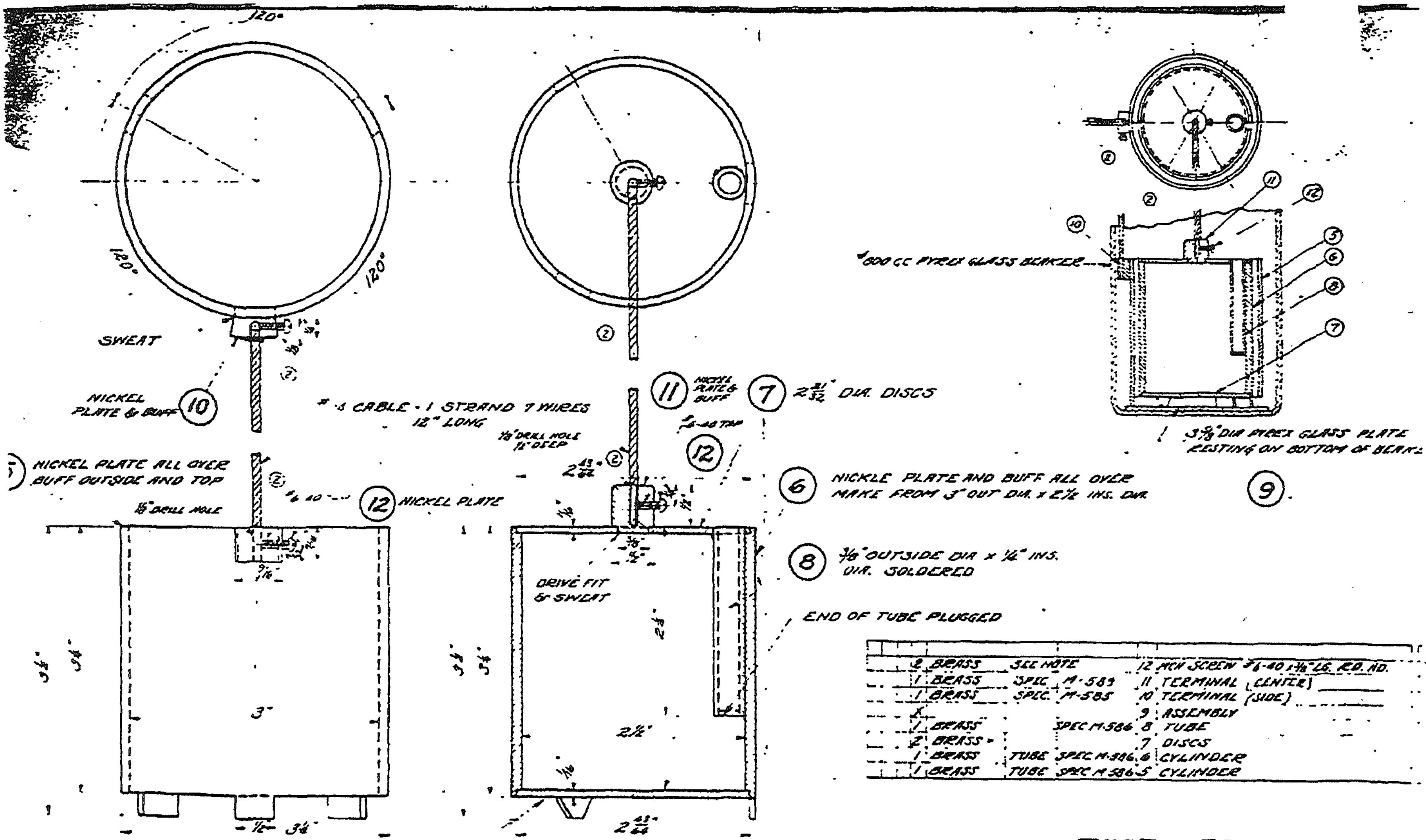
9. Rebalance the MEGOHMS dial and read the result as in 7.
10. If the MULTIPLIER is in the 100 or 1000 position, multiply result by 1.00 if an accuracy greater than 10% is desired.

FOR FURTHER INFORMATION SEE THE INSTRUCTION BOOK

DSW 001507

ADA 000860



2	BRASS	SEE NOTE	12	MCH SCREW	#6-40 x 1/8" LG. RD. HD.
1	BRASS	SPEC. M-585	11	TERMINAL	(CENTER)
1	BRASS	SPEC. M-585	10	TERMINAL	(SIDE)
1			9	ASSEMBLY	
1	BRASS	SPEC M-586	8	TUBE	
2	BRASS		7	DISCS	
1	BRASS	TUBE SPEC M-586	6	CYLINDER	
1	BRASS	TUBE SPEC M-586	5	CYLINDER	

...ERBORE BOTH ENDS OF PART
... DEEP FOR DISCS. PARTS
... FIT IN AND SOLDERED

ADD PTS 10 11 & 12 ...

TEST TERMINALS

G.E. DWG. Nº M-1553663

DSW 001508

SECTION 5

II. STANDARD SPECIFICATIONS

DSW 001509

SWANN CHEMICAL COMPANY

INSPECTION DEPARTMENT

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Aroclor 1254 Code No. 140111-1254-1

Grade: G. E. Compound No. 1476 Date Authorized 4/1/33

Supersedes Specification Dated -

Tolerable Limits Typical Value

The Swann Chemical Company shall test each 3500-pound batch of #1476 made for shipment to Pittsfield and shall forward their test data together with a two-quart advance sample for our Laboratory analysis and release.

The following are the chemical, physical and electrical specifications which must be met by the Swann Chemical Company:

Burn Point (A.S.T.M. D-92)	Higher than 350°C.
Viscosity at 98.9°C (ASTM D-88)	46-49 seconds Saybolt Universal.
Specific Gravity at 65°C (Referred to water at 15.5°C) (ASTM D-287-30T)	1.495-1.505
Pour Point (ASTM D-97)	+10°C ± 2°C
Color (NPA) (IRS Method H-3955618)	Less than 1.
Acidity (IRS Method H-3955613)	Less than 0.01 mg. NaOH/gm of sample
Chlorides and Sulphates (ASTM D117-31)	None
Evaporation at 100°C. for 6 hours (IRS Method H-3955622)	Less than 0.4%
Distillation Range (ASTM D-20)	10% Point - 350-355°C 50% Point - 355-362°C 90% Point - 362-375°C
Stability	There shall be no liberation of chlorine or chlorides when the material is heated at 100°C in glass vessels in contact with air for periods of at least one month.
Fixed Chlorine Content	53 ± 0.5%
Resistivity at 100°C under 500 volts D.C. (Electrodes-Drawing M-1559663)	Greater than 100 x 10⁹ ohms/cm³
Aging Characteristics at 100°C for 96 hours in air	No loss in resistivity over original value.
Dielectric Constant at 100°C (Method H-3955871)	4.15 - 4.35
Dielectric Strength (ASTM D-117-31)	Not less than 30.0 kilovolts.

DSW 001510

Approved by ____________ Chief Chemist

Approved by ____________ Sales Manager

Approved by ____________ Works Manager

Authorized by ____________ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl Crude Code No. 140110-1119

Grade: Aroclor 1119 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

	Tolerable Limits	Typical Value
C Sp. Gr. at 65/65°C Westphal	1.1326 - 1.1376	-
H % Chlorine	-	-
C Acid Number, Mgm NaOH/gm	-	-

DSW 001511

Approved by ______ Chief Chemist

Approved by ______ Sales Manager

Approved by ______ Works Manager

Authorized by ______ Chemical Director

ADA 000864

WATER_PCB-SD0000046031

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude Code No. 140110-1142

Grade: Aroclor 1142 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Sp. Gr. at 65/65°C, Westphal	1.373 - 1.378	-
H	% Chlorine	-	42 ± 0.5
C	Acid Number, Mgm NaOH/gm	-	-
C	Contamination: Diphenyl	None	
	Crystalline Aroclor	None	

DSW 001512

Approved by ____________ Chief Chemist

Approved by ____________ Sales Manager

Approved by ____________ Works Manager

Authorized by ____________ Chemical Director

ADA 000865

WATER_PCB-SD0000046032

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude Code No. 140110-1148

Grade: Aroclor 1148 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Sp. Gr. at 65/65°C, Westphal	1.438 - 1.440	-
H	% Chlorine	-	48.2 - 48.5
C	Acid Number, Mgm NaOH/gm	-	-
C	Contamination; Diphenyl	Negative	
	Crystalline Aroclor	Negative	

DSW 001513

Approved by ______ Chief Chemist

Approved by ______ Sales Manager

Approved by ______ Works Manager

Authorized by ______ Chemical Director

STANDARD SPECIFICATION
OF
THE SWANN CORPORATION

Product: Chlorinated Aroclor, Crude Code No. 140110-1150

Grade: Aroclor 1150 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Sp. Gr. at 65/65oC, Westphal	-	1.450 - 1.455
H	% Chlorine	-	-
C	Acid Number, Mgm NaOH/gm	+ -	-
C	Contamination: Diphenyl	Negative	
	Crystalline Aroclor	Negative	

DSW 001514

Approved by ______ Chief Chemist Approved by ______ Sales Manager

Approved by ______ Works Manager Authorized by ______ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude Code No. 140110-1154

Trade: Aroclor 1154 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Sp. Gr. at 65/65°C, Westphal	1.534 - 1.539	-
H	% Chlorine	-	54.3 to 55.8
C	Acid Number, Mgm, NaOH/gm	-	-
C	Contamination: Diphenyl	Negative	-
	Crystalline Aroclor	Negative	-

DSW 001515

Approved by ____________ Chief Chemist

Approved by ____________ Sales Manager

Approved by ____________ Works Manager

Authorized by ____________ Chemical Director

ADA 000868

WATER_PCB-SD0000046035

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude Code No. 140110-1160

Grade: Aroclor 1160 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Sp. Gr. at 90/90°C, Westphal	1.613 - 1.618	-
H	% Chlorine	-	59.9 to 60.3
C	Acid Number, Mgm NaOH/gm	-	.12 to 1.25
C	Contamination: Diphenyl	Negative	-
	Crystalline Aroclor	Negative	-

DSW 001516

Approved by __________ Chief Chemist

Approved by __________ Sales Manager

Approved by __________ Works Manager

Authorized by __________ Chemical Director

ADA 000869

WATER_PCB-SD0000046036

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude Code No. 140110-1162

Grade: Aroclor 1162 Date Authorized Tent 12/23/32

O - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Sp. Gr. at 90/90°C, Westphal	1.637 - 1.642	-
H	% Chlorine	-	61.7 - 62.1
C	Acid Number, Mgm NaOH/gm	-	.28
C	Contamination: Diphenyl	Negative	-
	Crystalline Aroclor	Negative	-

DSW 001517

ADA 000870

Approved by ____________ Chief Chemist

Approved by ____________ Sales Manager

Approved by ____________ Works Manager

Authorized by ____________ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude
Code No. 140110-1168

Grade: Aroclor 1168
Date Authorized 7/3/34

C - Control Test
Supersedes Specification Dated 12/23/32

H - History Test

		Tolerable Limits	Typical Value
xC	Hold Point, °C	145 - 165	157
H	Chlorine, %	-	67.36
C	Contamination: Diphenyl	Negative	

xChanged from previous specification.

DSW 001518

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S. Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Crude Code No. 140110-1169

Trade: Aroclor 1169 Date Authorized 7/3/34

C - Control Test Supersedes Specification Dated 12/23/32

H - History Test

		Tolerable Limits	Typical Value
*C	Hold Point, °C	225 - 250	240
H	% Chlorine	-	68.8
C	Contamination: Diphenyl	Negative	

*Changed from previous specification

DSW 001519

Approved by A. B. Gerber
Chief Chemist

Approved by Robert S. Weatherly
Sales Manager

Approved by R. R. Cole
Works Manager

Authorized by Paul Logue
Chemical Director

ADA 000872

WATER_PCB-SD0000046039

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl:HB Mix Crude Code No. 140110-2565

Grade: Aroclor 2565 Date Authorized Tent 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
C	Softening Point, °C, Barrett	78° ± 3°	79.4
H	Softening Point, °C, D36-26	-	70.0
H	% Chlorine	-	64.9
C	Acid Number, Mgm NaOH/gm	-	0.3 - 1.0
C	Blooming Test, 5 weeks	Negative	-
H	Loss at 163°C, D6-27	-	.23
H	Sp. Gr. at 25/25°C, D70-27	-	1.733
H	% Iron		.11

Aroclor 2565 is the product of chlorinating Crude High Boiler and Diphenyl (25:75) to 65% Cl.

DSW 001520

Approved by ____________ Chief Chemist

Approved by ____________ Sales Manager

Approved by ____________ Works Manager

Authorized by ____________ Chemical Director

ADA 000873

WATER_PCB-SD0000046040

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl: HB Mix Crude Code No. 140110-4065

Grade: Aroclor 4065 Date Authorized 7/3/34

C - Control Test Supersedes Specification Dated 12/23/32

H - History Test

	Tolerable Limits	Typical Value
xC Soft Point, Barrett, °C	Std. at 78 ± 2°C	77.0
xH % Chlorine	64 - 64.8	64.5
xAcid Number, Mgm NaOH/gm		.42
C Contamination: Diphenyl	Negative	
Crystalline Aroclor	"	

Aroclor 4065 is the product from chlorination of a mixture of diphenyl and distilled high boiler (60:40) to a Barrett softening point of 78°C ± 2°.

xChanged from previous specification.

DSW 001521

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

ADA 000874

WATER_PCB-SD0000046041

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated High Boiler, Crude Code No. 140110-5060

Grade: Aroclor 5060 Date Authorized Tent. 12/23/32

O - Control Test Supersedes Specification Dated

H - History Test

		Tolerable Limits	Typical Value
O	Softening Point, Barrett, °C	118 ± 2° Tent.	117
H	% Chlorine	-	59.9 - 60.2
O	Acid Number, Mgm NaOH/gm	-	2.2
O	Contamination: Diphenyl	Negative	-
	Crystalline Aroclor	Negative	-

Aroclor 5060 is distilled High Boiler chlorinated to 60% Cl.

DSW 001522

Approved by ____________ Chief Chemist

Approved by ____________ Sales Manager

Approved by ____________ Works Manager

Authorized by ____________ Chemical Director

ADA 000875

WATER_PCB-SD0000046042

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1242

Grade: Aroclor 1242 Date Authorized 7/3/34

0 indicates control tests which are to be made on every lot. Supersedes Specification Dated 12/23/32

		Tolerable Limits	Typical Value
0	Sp. Gr at 65/65°C. Westphal	1.368 ± .005	1.365 - 1.372
	Sp. Gr. at 25/25°C., D70-27		1.374 - 1.393
0	Lovibond Color, 1", Yellow #510	0.1 - 0.5	0.1 - 0.5
	Pour Point, °C., D97-28		-17.8 to -20.6
	Viscosity at 98.9°C, D88-26		-34.0 to -34.6
x0	at 54.4°C	50 - 53	
	37.8°C		82 to 87
	Distillation Range, D20 28T		
	1st drop, °C	310 - 315	311 - 314
	10%		315 - 317
	50%		320 - 321
	90%	335 - 345	335 - 339
	End		335 - 356
	Coeff. of Expansion		
	Flash Point, °C., D92-24		176 - 180
	Fire Point, °C., D92-24		334 to +350
	% Loss on Heating at 165 C., D6-27		2.9 - 3.6
	Refractive Index, 20°C., D-line		1.6269 - 1.6285
0	Acid Number, Mgm. NaOH/gm	.01 Max.	
	Resistivity at 100°C., 500VDC, Ohm-cm		100 to 300 x 10^9
	Dielectric Constant at 100°C., 1000 cps.		4.92 - 4.94
	Power Factor at 100°C., 1000 cps.		0.6 to 3.0

xChanged from previous specification

DSW 001523

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

ADA 000876

STANDARD SPECIFICATION
OF
THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1248

Grade: Aroclor 1248 Date Authorized 7/3/34

C - Control Test Supersedes Specification Dated 12/23/32

H - History Test

	Tolerable Limits	Typical Value
C Sp.Gr. at 65/65°C, Westphal	1.435 ± .005	1.439
H Sp.Gr. at 25/25°C, D70-27		
C Color, Lovibond, 1", Yellow #510		
H Pour Point, °C, D97-28		-6.6
H Viscosity at 98.9°C		36.8
*C Viscosity at 54.4°C	73 - 80	83.9
Viscosity at 37.7°C		218.0
H Flash Point, °C		193
H Fire Point, °C		
H % Loss at 163°C, D6-27		
C Acid Number, Mgm NaOH/gm	0 - .01	.003
H % Free Chlorides		
H Distillation Range: D20-28T		
1st drop, °C		331
10%		332
50%		338
90%		358
100%		

*Changed from previous specification.

DSW 001524

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S. Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

ADA 000877

WATER_PCB-SD0000046044

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1249
140111-1251

Grade: Aroclor 1249
Aroclor 1251 Date Authorized

Supersedes Specification Dated

Tolerable Limits Typical Value

Aroclors 1249 and 1251 are not likely to be made directly in the future but only by blending 1248 and 1250 or 1250 and 1254 respectively.

The tests to be made on these Aroclors, however produced, are the same as for Aroclor 1248. Specification limits cannot be laid down until history is obtained.

DSW 001525

Approved by ______ Chief Chemist

Approved by ______ Sales Manager

Approved by ______ Works Manager

Authorized by ______ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl Distilled Code No. 140111-1250

Grade: Aroclor 1250 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

	Tolerable Limits	Typical Value
C Sp.Gr. at 65/65°C, Westphal	- -	1.448
H Sp.Gr. at 25/25°C, D70-27	- -	- -
C Color, Lovibond, 1", Yellow #510	- -	- -
H Viscosity at 98.9°C	- -	38.3 Sec.
54.4	- -	97 Sec.
37.7	- -	318 Sec.
H Flash Point, °C, D92-24	- -	190 - 198
H Fire Point, °C, D92-24	- -	None at 340
H Loss at 163°C, D6-27	- -	- -
H Pour Point, °C, D97-28	- -	- -
C Acid Number, Mgm NaOH/gm	.01 Max.	.004
H % Free Chlorides	- -	- -
H Distillation Range, D20-28T		
1st drop, °C	- -	332
10%	- -	335
50%	- -	343
90%	- -	372
End	- -	-

DSW 001526

Approved by ______________ Chief Chemist

Approved by ______________ Sales Manager

Approved by ______________ Works Manager

Authorized by ______________ Chemical Director

ADA 000879

WATER_PCB-SD0000046046

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1262

Grade: Aroclor 1262 Date Authorized 7/9/3?

O - Control Test Supersedes Specification Dated 12/23/32

H - History Test

	Tolerable Limits	Typical Value
H Sp. Gr. at 25/25°C, D70-27		1.648 - 1.658
O Sp. Gr. at 90/90°C, Westphal	1.632 ± .005	1.633 - 1.638
xO Lovibond color, 1", yellow 510	.25 - 1.00	0.4 - 1.4
O N P A Color		
H Pour Point, °C, D97-28		34.9 - 38.0
xO Viscosity at 98.9°C, D88-26	88 - 98	91.3 - 103.0
H Distillation Range, D20-28T		
1st drop		373 - 376
10%		375 - 378
50%		380 - 383
90%		392 - 394
End		396 - 404
H Coeff. of Expansion		-
H Loss at 163°C, D6-27		.48 - .56
H Refractive Index, 20°C, D-line		1.6501 - 1.6517
xO Acid Number, mgm NaOH/gm	0 - 0.01	.0048
% Chlorine		61.4 - 62.5
H % Fee chlorides		

xChanged from previous specification.

DSW 001527

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S. Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

ADA 000880

WATER_PCB-SD0000046047

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1264

Grade: Aroclor 1264 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test. Tolerable Limits Typical Value

H Sp.Gr. at 25/25°C, D70-27

C Color Lovibond, 1", Yellow 510

C Softening Point, Barrett, °C

H Softening Point, D36-26-°C

H % Loss at 163°C, D6-27

C Acid Number, Mgm NaOH/gm

Aroclor 1264 is in experimental stage where requirements cannot be specified. If further produced the above tests are desired.

DSW 001528

Approved by __________ Chief Chemist

Approved by __________ Sales Manager

Approved by __________ Works Manager

Authorized by __________ Chemical Director

ADA 000881

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1268

Grade: Aroclor 1268 Date Authorized 7/9/34

C - Control Test Supersedes Specification Dated 12/23/32

H - History Test

	Tolerable Limits	Typical Value
H Sp. Gr. at 25/25°C, Pyconometer		1.804 - 1.811
H % Loss at 163°C, D6-27		.15 - .24
C Acid Number, Mgm NaOH/gm	.05 Max.	
xC Hold Point	135° - 160°	140 - 155
C Color f 1" cube not greater than	Standard	

xChanged from previous specification.

DSW 001529

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S. Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1269

Grade: Aroclor 1269 Water Quenched Date Authorized 7/9/34

C - Control Test Supersedes Specification Dated 12/23/32

H - History Test

	Tolerable Limits	Typical Value
H Sp.Gr. at 25/25°C, Pycnometer		
H Loss at 163°C, D6-27		
xC Hold Point, °C	225 - 255	
C % Moisture at 105°C	0 - 1.0	
C Color		

Moisture Test: Dry 10 grams in moisture dish at 105°C for 3 hours or longer.

xChanged from previous specification.

DSW 001530

Approved by A. B. Gerber, Chief Chemist

Approved by Robert S. Weatherly, Sales Manager

Approved by R. R. Cole, Works Manager

Authorized by Paul Logue, Chemical Director

ADA 000883

WATER_PCB-SD0000046050

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl Distilled Code No. 140111-1819

Grade: Aroclor 1819 Date Authorized Tent. 12/23/32

Supersedes Specification Dated

	Tolerable Limits	Typical Value
Sp. Gr. at 25/25°C, Westphal		1.15
Color, Lovibond, 1", Yellow #510		
Freezing Point, °C		14.0
Flash Point, °C, D92-24		158
Fire Point, °C, D92-24		177
Sediment		None
Acid number, mgm NaOH/gm		.005

All of the above items should be determined on every batch until history is obtained.

Aroclor 1819 is a eutectic mixture of para 25% and ortho 75% chlorodiphenyl.

DSW 001531

Approved by __________ Chief Chemist

Approved by __________ Sales Manager

Approved by __________ Works Manager

Authorized by __________ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl, Distilled Code No. 140111-1848

Grade: Aroclor 1848: Comstock & Wescott Date Authorized Tent. 12/23/32

C-Control Test Supersedes Specification Dated

	Tolerable Limits	Typical Value
C Distillation Range: D20-28T but corrected for emergent stem of thermometer.		
1st drop, °C		
10%		
50%		
90%	344 - 362	
100%	362 - 370	
C Acid number, mgm NaOH/gm		
C Color Lovibond, 1", yellow #510		
C Sp. Gr. at 65/65°C, Westphal		1.433

Aroclor 1848 is a middle cut from the distillation of Aroclor 1148; it is a fractional portion of Aroclor 1248.

DSW 001532

Approved by ______ Chief Chemist

Approved by ______ Sales Manager

Approved by ______ Works Manager

Authorized by ______ Chemical Director

ADA 000885

WATER_PCB-SD0000046052

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated Diphenyl; HB Mix Code No. 140111-4465

Grade: Aroclor 4465 Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

	Tolerable Limits	Typical Value
H Sp. Gr. at 25/25°C, D70-27	- -	1.712 - 1.716
H " " 65/65°C, Westphal	- -	1.695 - 1.702
C Lovibond Color, 1", Yellow #510	4.3 - 6.4	4.3 - 5.3
C Softening Point, Barrett, °C	71 - 76	70.5 - 76
H Softening Point, °C, D36-26	- -	60 - 62.7
H Coeff. of Expansion	- -	- -
H % Loss at 163°C, D6-27	- -	.23 - .29
H Refractive Index	- -	1.6650
C Acid Number, Mgm NaOH/gm	0 - .035	.006 - .03
C Crystallization Test (See below)	None	- -

Aroclor 4465 is the product obtained from distillation of Aroclor 4065 which is a mixture of 40% distilled High Boiler and 60% Diphenyl chlorinated to 64.2 to 64.8% chlorine with Barrett softening point of 78 to 80°C (Comparison standard valued at 78°).

Aroclor 4465 is designated as "Coal Tar Resin, Clear" in correspondence and on shipments to H. H. Robertson Co.

Crystallization Test: Transfer 30-40 grams of sample to a 150 cc beaker, heat to 100°C, add a minute trace of powdered Aroclor 1268 as seed crystals and maintain at 100-105°C for 24 hours. At end of this time it should be noted whether the seed crystals have grown or have disappeared.

DSW 001533

Approved by ______ Chief Chemist Approved by ______ Sales Manager

Approved by ______ Works Manager Authorized by ______ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Chlorinated High Boiler Code No. 140111-5460

Grade: Aroclor 5460 # Distilled Date Authorized Tent. 12/23/32

C - Control Test Supersedes Specification Dated

H - History Test

	Tolerable Limits	Typical Value
C Lovibond Color, 1", Yellow #510		
H Sp. Gr. at 25/25°C, D-70-27		
C Soft. Point - Barrett, °C		112°
H Soft. Point - D36-26, °C		
H Coeff of Expansion		
H Loss at 163°C, D6-27		
C Acid Number, Mgm NaOH/gm		
H Refractive Index		
C Crystallization		

Aroclor 5460 is the product from the distillation of Aroclor 5060 which is distilled High Boiler Chlorinated to 60% Cl.

Crystallization Test: Until further consideration is given to this test, transfer 30-40 grams to a beaker, melt down, then maintain at 100-105°C for one week. Note if there is any tendency toward crystallization. Examine daily.

OSW 001534

Approved by _______ Chief Chemist

Approved by _______ Sales Manager

Approved by _______ Works Manager

Authorized by _______ Chemical Director

STANDARD SPECIFICATION OF THE SWANN CORPORATION

Product: Aroclor Moistureproofing Compound Code No. 140112-301

Grade: Wax #301 Date Authorized 10/4/34

Supersedes Specification Dated

	Tolerable Limits	Typical Value
Softening Point (A.S.T.M.)		58.0°C
Furol Viscosity at 98.9°C		45 seconds

Wax 301 is a mixture of Aroclor 4465 - 96% and Paraffin (54°C) 4%.

DSW 001535

Approved by A. B. Gerber 10/11/34 Chief Chemist

Approved by Robert S. Weatherly Sales Manager

Approved by R. R. Cole Works Manager

Authorized by Paul Logue

ADA 000888

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SECTION 8

III. LABORATORY TEST EQUIPMENT

DSW 001536

SWANN CHEMICAL COMPANY

INSPECTION DEPARTMENT

ADA 000889

NECESSARY AROCLOR EQUIPMENT

TEST	EQUIPMENT: Available to be sent to St. Louis	EQUIPMENT: Not Available
Specific Gravity		Westphal balance Dubbard bottles Gravity jars Special hydrometers
Acidity	None	
Free Chlorides	None	
Color		Lovibond colorimeter
Resistivity	Megohm meter Cells	
Dist. Range	Flasks Condensers Shield Thermometer	
Viscosity		Viscosimeter Efflux receptacles Thermometers
Dielectric Constant	Oven, Serial No. 621-61 Audio 2 stage amplifier Audio oscillator Resistance box Std. air condenser Balancing condenser Vernier condenser Condenser cell 2 storage batteries Oven thermometer	
Power Factor	Same as D. C. Power factor cell	
Aging Test	Same as resistivity	
Loss On Heating		Oven with rotating shelf Thermometer
Pour Point	None except thermometer	
Chlorine		2 Parr bombs and tightening rack

DSW 001537

ADA 000890

WATER_PCB-SD0000046057

PAGE NO. 2

TEST	EQUIPMENT Available to be sent to St. Louis	Not Available
Soft. Pt.		A.S.T.M. assembly Barrett assembly
Mold Pt.		M.C.A. thermometer
Refrac. Index	Refractometer	
Flash Pt.		Cleveland open cup assembly and thermometer
Benzene		Barrett dist. equipment. Freezing pt. thermometer Wash test standards
High Boiler		Vigreaux column

ers

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SECTION NO. 6

SCHEDULE OF DRAWINGS

DSW 001540

ADA 000893

WATER_PCB-SD0000046060

SCHEDULE OF DRAWINGS

I. GENERAL

Plant Layout - June 1955	C-6850
Diagrammatic Flow Sheet	C-6851

II. BENZOL HANDLING

Layout Relocating Storage Above Ground	C-6888
Foundation For Storage Tank & Fence	C-6889
Fence Around Feed Tank	C-6891

III. CONVERTER UNIT

Layout as of June 1955	C-5596
Hammerwelded Reaction Pot	C-5580
Fractionating Column & Trap	C-5582
Brick Setting	C-5583
Door & Burner Castings	C-5584
Detail of Shell	C-5585
Detail of Stack	B-5586
Stainless Steel Piping	C-5587
Structural Steel	C-5588
Structural Steel	C-5589
Foundations	B-5590
Floor Grating & Handrailing	C-5591
Inside Fittings for Fractionating Column	C-5592
Gas Piping for Burners	C-5593

IV. SEPARATING EQUIPMENT

Benzol Still - Assembly	C-6857
" " - Fractionating Column & Tanks	C-5257
" " - Structural Steel Support	C-5245
Diphenyl Still - Assembly	C-6574
" " - Alteration to present Still	C-6570
" " - Rumsey Pump & Support	C-6571
" " - Heater	C-6572
" " - Steel Support	C-6573
" " - Alterations	C-6455

DSW 001541

ADA 000894

High Boiler Still	- Assembly	C-6480
" " "	- Pump & Support	C-6481
" " "	- Main Packing Box	C-6482
" " "	- Pump Drive Head Housing	C-6483
" " "	- Motor Base	C-6484
" " "	- Still Body	C-64[illegible]
" " "	- Miscellaneous Castings	C-6486
" " "	- Pump Shaft, Foam Trap and Steam Coil	C-6487
" " "	- Still Support	C-6488
" " "	- Column & Receiver	C-6489
" " "	- Piping	C-6490
" " "	- Heater	C-6491
" " "	- Extension to Heater Support	C-6492
" " "	- Receiver & Sight Glass	C-6652
" " "	- General Layout	C-6653
Lectrodryer	- General Layout	C-6459

V. <u>CHLORINATING EQUIPMENT & HCl ABSORBERS</u>

Layout - June 1955		C-6655
Melting Pot		C-5598
Steel Supporting Structure		C-5599
Ventilating Hood		C-6398
" "		C-6399
" "		C-6400
Chlorinator & Fittings		C-6856
Diagrammatic Layout		C-6852
HCl Absorbers	- Layout Dec. 1955	C-6585
" "	" Dec. 1929	C-5566
" "	- 20,000 Gallon Acid Tank	C-6586
" "	- " " " " Fdn.	C-6587
" "	- Acid Cooling Coils	C-6591
" "	- Tank for 20°Be Acid	C-6417
" "	- Steel Stairs & Towers	C-6457
" "	- " " " "	C-6458
" "	- Tank Car Loading Station	C-6468

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VI. DISTILLATION EQUIPMENT

Vacuum Still (Badger)	- General Layout	C-6858
" " "	- Blending Tank	C-6075
" " "	- Tubejet Support	C-6499
" " "	- Monel Foam Trap	C-6658
1269 Still	- General Layout	C-6859
" "	- Setting	C-6121
" "	- Pot	B-6123
" "	- Raymond Dust Collectors	B-6124
" "	- Exhaust Fan & Ductwork	C-6478
" "	- Hood for Flaker	C-6735

WTD/jw
6/27/56

DSW 001543

ADA 000896

WATER_PCB-SD0000046063

DSW 001544

SECTION NO. 1

LIST OF PLANT EQUIPMENT IN USE AT ANNISTON, NOTING THAT WHICH IS AVAILABLE FOR TRANSFER TO EAST ST. LOUIS, ALONG WITH APPROXIMATE WEIGHTS, COSTS, ETC.

BY: W. T. DURRETT
ENGINEERING DEPARTMENT

Sections are as follows:-

- Benzol Handling Equipment
- Converter Unit
- Separating Equipment
- Chlorinating Equipment
- Muriatic Acid Plant
- Distillation Equipment

PHENOL HANDLING EQUIPMENT

Item No.	Tag No.	Description	Size	Manufacturer	Reference	Approx. Weight	Approx. Cost Not Installed	Present Use	Est. Cost of Dismantling & Loading
1	[illegible]	[illegible] Pump - Capacity [illegible] gals. Phenol per min. with 3 HP Explosion Proof Motor	1 1/2"	[illegible] Pump Corp.	[illegible]	[illegible]	$ [illegible]	Pumping Phenol from Tank Cars to Storage	$ [illegible]
2		Stl. Horizontal Storage Tank Capacity 10,[illegible] gallons	10' dia. x 15'	Local	Dwg. [illegible]	11,[illegible]	-	Phenol Storage	[illegible]
3	P-[illegible]	Rotary Pump Direct Connected to 1 1/2 HP Motor [illegible] R.P.M.	1 1/2"	Viking Pump Co.	[illegible]	[illegible]	111.00	Pumping Phenol from Storage Tank to Feed Tanks	[illegible]
4	-	[illegible] Lin. Ft. 7 Ft. High Cyclone Fence with (1) 4 Ft. gate (Posts set in concrete and cannot be removed)	-	Cyclone Fence Co.	Dwg [illegible] [illegible]	4,[illegible]	[illegible]	Enclose Phenol Storage Tank	10.00
5	-	[illegible] Lin. Ft. 7 Ft. high cyclone fence with (2) 5 Ft. gates (Posts set in concrete and cannot be removed)	-	Cyclone Fence Co.	[illegible] [illegible]	1,[illegible]	[illegible]	Enclose Phenol Feed Tanks	[illegible]
6	-	[illegible] Flame Arrester & Vent	2"	Oil Conservation Engineering Co.	-	-	[illegible]	On Phenol Storage Tank	[illegible]
7	-	Model [illegible] Tank-O-Meter	[illegible]	[illegible] Instrument Co.	-	-	[illegible]	On Phenol Storage Tank	[illegible]
8	-	Four Closed Top Vertical Tanks, Steel	(3) 5' dia. x 5' high	-	Dwg. [illegible]	4,[illegible]	[illegible]	Phenol Feed Tanks	[illegible]
			(1) 4' dia. x 5' high	-	-	1,[illegible]	[illegible]	"	
9	-	[illegible] Pump [illegible] HP	-	[illegible] Pump Company	-	[illegible]	[illegible]	Pumping Phenol from Feed Tanks to Converter Unit	[illegible]

CONVERTER UNIT

Item No.	Tag No.	Description	Size	Manufacturer	Reference	Approx. Weight	Approx. Cost Not Installed	Present Use	Est. Cost of Dismantling & Loading
1	-	No. 1 Converter Unit (Complete)	-	-	-	-	-	Not in use	-
2	-	No. 2 Converter Unit Complete with platforms, columns, condensers, etc. as shown on Dwgs. [illegible] to [illegible]	-	-	Dwgs. [illegible] to [illegible] inc.	[illegible],000	14,[illegible]	Diphenyl Manufacture	[illegible]
3	-	Chain Hoist	2 Ton	Yale & Towne	-	2,000	[illegible]	Diphenyl Plant Repairs	-
4	-	2 Steel Tanks, closed top Vertical	5' dia. x [illegible]' high	-	Dwg. [illegible]	4,[illegible]	[illegible]	Crude Diphenyl Catch Tanks	[illegible]
5	-	Iron Case Gas Meter	[illegible]	[illegible] Metal Works	-	1,000	[illegible]	Metering [illegible] Gas	-

DSW 001546

ADA 000899

Item No.	Tag No.	Description	Size	Manufacturer	Reference	Approx. Weight	Approx. Cost Not Install-ed	Present Use	Est. Cost of Dismantling & Loading
6	-	Two Unit Hydrogen Scrubber Type [illegible] complete with [illegible] Cooler and 5' dia.-10' high catch tank	100	Pittsburgh [illegible] Corp.	Dwg. [illegible]	[illegible]	[illegible]	Scrubbing Hydrogen Gas	$ [illegible]
7	-	Horizontal Steel Storage Tank with Steel Supports and Steam Heating Coils	10' dia. x [illegible]	Local	-	12,[illegible]	[illegible]	Crude High Boiler Storage	[illegible]
8	-	Thirty-three Steel Pans	[illegible] x 6" deep	-	-	[illegible]	[illegible]	Distilled High Boiler	[illegible]
9	-	Platform Scale - Capacity 2,000 lbs. 17 x 26 Platform		Howe		[illegible]	[illegible]		[illegible]
10	-	Five cast iron reaction pots - two of these pots have old style center cores and will have to be converted to present type pots by welding in new style bottoms	[illegible]	(3) by [illegible] (2) by Blaw-Knox	Dwg. [illegible]	[illegible]	[illegible]	Unit No. 1	[illegible]
11	-	Sump for bottom of fractionating column, [illegible]	1'-6" dia. [illegible]	Local	Dwg. [illegible]	[illegible]	75.00	Spare	[illegible]
12	-	Lead Trap Unit [illegible]	[illegible] dia. x [illegible]	-	Dwg. [illegible]	[illegible]	[illegible]	Spare	[illegible]
13	-	Three covers for present pots	-	-	-	1,[illegible]	[illegible]	"	[illegible]
14	[illegible]	Centrifugal pump with 1/4 HP Motor, Fig. [illegible]	1"x3/4"	Gould Pumps Inc.	P.O.-[illegible]	[illegible]	[illegible]	Two in Service	10.00 (items 14–16)
15	104	Centrifugal pumps with 1/4 HP Motor Fig. [illegible]	1"	" " "	-	[illegible]	44.[illegible]	" " "	
16	107	Centrifugal pump with 1/4 HP Motor Figure [illegible]	1"	" " "	-	[illegible]	44.[illegible]	" " "	
17*	-	Automatic Potentiometer Controls with Motor Operated Valves		[illegible]	-	[illegible]	-	[illegible]	-
18*	-	6 Point [illegible]		" "	-	[illegible]	-	Diphenyl Unit	-
19*	-	6 Point Potentiometer		Brown Inst. Co.	-	50	-	Chlorinator, Diphenyl	-
[illegible]	-	[illegible] Flow Meter		[illegible]	-	10	-	[illegible] to Unit	

DSW 001547:

[illegible] EQUIPMENT

Item No.	Tag No.	Description	Size	Manufacturer	Reference	Approx. Weight	Approx. Cost Not Installed	Present Use	Estimated Cost of Dismantling & Loading
1	-	Iron Gas [illegible] Meter	[illegible]	[illegible]	-	[illegible] lbs.	$ [illegible]	[illegible]	-
2	-	Benzol Still complete with Fractionating Column, Condenser and Steel Support		Local	Dwg. [illegible]	[illegible]	[illegible]	Distilling Benzol	$ [illegible] (items 2–5)
3	-	Diphenyl Still complete with [illegible] Pump, Gas Fired Heater, Fractionating Column, Condenser and Steel Support		Local	Dwg. [illegible]	[illegible]	[illegible]	Distilling Diphenyl	
4	-	High Boiler Still complete with [illegible] Pump, Gas Fired Heater, Fractionating Column, Condenser and Steel Support		Local	Dwg. [illegible]	[illegible]	[illegible]	Distilling High Boiler	
5	P-[illegible]	Rotary Type Vacuum Pump - Serial [illegible] (Not in good operating condition)	[illegible]	[illegible] Mfg. Co.	-	[illegible]	[illegible]	Not in use	
6	P-[illegible]	[illegible] Vacuum Pump - Serial [illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	Used only when steam is not available for [illegible]	[illegible]

[illegible] EQUIPMENT

Item No.	Tag No.	Description	Size	Manufacturer	Reference	Approx. Weight	Approx. Cost Not Installed	Present Use	Estimated Cost of Dismantling & Loading
1	-	Chlorine Vaporizer - [illegible] in Place	[illegible]	Local	-	[illegible]	[illegible]	Vaporizing Chlorine	[illegible]
2	-	Steel Chlorinators with Fittings	[illegible]	Local	Dwg. [illegible]	[illegible]	[illegible]	Chlorinators	[illegible] (items 2–4)
3	-	Two Centrifugal Pumps direct connected to [illegible] HP explosion proof motor	[illegible]	Gould Pumps Inc.	-	[illegible]	[illegible]	With Chlorinators	
4	-	Two Flat Top Vertical Tanks - Steel, Equipped with Heating Coils	[illegible]	Local	Dwg. [illegible]	[illegible]	[illegible]	Holding Tanks for Diphenyl	
5	-	Two Structural Steel Traps	[illegible]	Local	Dwg. [illegible]	[illegible]	[illegible]	Traps for [illegible]	[illegible]
6	-	Ventilating Hood With Stacks	-	-	Dwgs. [illegible]	[illegible]	[illegible]	Over Chlorinators	[illegible]

DSW 001548

ADA 000901

Item No.	Tag No.	Description	Size	Manufacturer	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	-	Flat Top Vertical Steel Tank Equipped with heating coils and air distributor and [illegible]	7'-6" dia.x 6'-6"	Local	Dwg. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8*	-	Platform Scale (This is old Furnace charging Car Scale Rebuilt)	2,000#	Fairbanks	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9*	I-[illegible]	Worthington-[illegible] Vertical two cylinder air compressor, Serial #[illegible], direct connected to 15 HP Motor	8 1/2" x 4 1/2"	Worthington Pump & Machinery Corp.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10*	-	Vertical Steel Air Receiver for Above Compressor	3'-6" dia.x 8'-6"	Local	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
				[illegible] AND [illegible]					
1	-	Rubber Lined Steel, Horizontal Storage Tank	5'-6" dia.x 8'-6"	Goodrich Rubber Co.	Dwg. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-	Rubber Lined Steel Horizontal Storage Tank	10'-[illegible] 22'-6" 10,000 Gals.	Goodrich Rubber Co.	Dwg. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	-	Structural Steel Stairs, etc.	-	-	Dwg. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	-	Absorption tower complete with 18 Vitreosil Absorbers 1 - Blackburn and 17 Head	-	Thermal Syndicate	Dwg. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	-	Pyrex Cooling Coil	-	Corning Glass Co.	Dwg. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	-	American Blower Co. #4, Type "V" Fan CW., [illegible], Arrangement #3 with ball bearings and type C.L. wheel. All parts in contact with vapors handled to be rubber covered - Direct connected to 1/4 HP, 1800 RPM Motor	#2	American Blower Co.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	S-61	Small Platform Scale 17" x 26"	2,000 lbs.	Howe	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DSW 001549

ADA 000902

DISTILLATION EQUIPMENT

Item No.	Tag No.	Description	Size	Manufacturer	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VACUUM STILL									
1	-	Vacuum Distillation Unit complete with #6 Quimby Pump, Gas Fired Heater, Condenser & Receiver, Traps, Charging Tanks and Tube-jet Air Pump	-	E.B. Badger & Sons with alterations	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-	Two Aerolog Blending Tanks with Structural Steel Support and Lightning Mixers	200 gals. each	-		[illegible]	[illegible]	[illegible]	[illegible]
3	-	Plate and Frame Filter Press with Motor Driven Gear Pump (Chardonfor)	12"	Sperry & Company		[illegible]	[illegible]	[illegible]	[illegible]
4	-	Blower and Ductwork for Ventilation	-	-		[illegible]	[illegible]		[illegible]
5	-	6 Point Wheelco Recording Pyrometer	6 Pt.	Wilson-Maeulen				[illegible]	
6	-	Quimby Screw Pump with bed plate and extended shaft with pedestal bearing	#6	Quimby Pump Co.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1200 STILL									
1	-	Seven Steel Distillation Pots (Battered but Usable)	5'-0" dia. x 8'-0"	Local	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-	Two Gas Fired Heating Furnaces	-	Local	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	-	Flaker Roll - Not worth moving	2'-0" dia. x 1'-0"	"				[illegible]	
4	-	Gas Dust Collecting System	-	"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	-	Raymond Dust Collecting Cyclones with Exhauster	-	Raymond Brothers	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	-	Chain Hoist	1 Ton	Yale & Towne		[illegible]	[illegible]	[illegible]	
7	-	Small Platform Scale 17x26	2,000 lbs.	Howe		[illegible]	[illegible]	[illegible]	

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WATER_PCB-SD0000046070

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ELBEE

TO DUPLICATE ORDER

No 116-F