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PROGRESS REPORT
PLANT TECHNICAL SERVICES DEPT.--W. G. KRUMMRICH PLANT

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* TO RECEIVE DETAIL SECTION

C O N F I D E N T I A L

TITLE: Process Improvement Plan - Aroclor, Pydrauls, and Pyranols

PERSONNEL: W. B. Johnson, L. G. Cole, D. C. Armstrong, E. E. Martin (J.R.Savage)

PROBLEM: Present a specific plan with short range and long range objectives for improving Aroclor rates, quality, yields, costs, Pollution control, corrosion control, safety and other studies.

SUMMARY:

	Spec. or Std.	1963 or Historical	Present	IMMEDIATE TARGET	LONG RANGE Target (10/66
Rate	20.4M lb/yr.	19.1M	23.8M	28.6M lb/yr	39.0M lb/yr
Yields (Biphenyl)	93.49%	96.1%	97.0%	97.5%	98.0%
Process Efficiency		85.49%	92.05%	92.5%	93.0%
Manufacturing Costs	7.112/cwt	6.884/cwt	6.451	6.101/cwt	5.983/cwt
Total Savings				$110,000/yr	$261,000/yr

Most of the savings claimed result from increased divisor by virtue of increased rate and are dependent on sales.

The Aroclor quality objective of meeting Anniston's quality by 8-1-64 has been met as far as resistivity is concerned, but has not been as far as stability is concerned. The plan to meet this goal is contained herein.

Specific projects have been installed within the last 3 months to reduce air and stream pollution, reduce corrosion, and improve department safety.

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DETAILS

Background

Liquid Aroclors are chlorinated diphenyl and are manufactured at WGK and Anniston by Monsanto. Diphenyl is obtained from Anniston and the following operations are performed to produce Aroclors.

1. Chlorination
2. Aeration
3. Distillation
4. Blending
5. Storing

Aroclors are designated by a four digit number such as 1142 and 1242. Any Aroclor in the 1100 series indicates crude Aroclor that has not been refined by distillation. The 1200 series indicates refined Aroclor. The last two digits, 42 in this example, indicates the degree of chlorination. Aroclor 1242 has 42% chlorine by weight, and at WGK only 1242, 1248, 1254, and 1260 liquid Aroclors are produced.

Monsanto is the sole national producer of Aroclors. Electrical and non-electrical grades of Aroclors are produced at WGK. The national sales for electrical grade Aroclors for 1963 is estimated at 26M lbs. Sales forecasts indicate 35% increase in sales of electrical grade Aroclor within the next 3-5 years.

I. Aroclors

A. Rate

Summary

	Avg. Prod. Rate M lb/yr	Downtime %	Remarks
Std.	20.4	8.0%	2% Mechanical, 2% Process, and 4% Other downtime
1963	19.1	15	Reduced avg. prod. rate resulted from scheduled or inventory downtime due to lack of sales or storage. Inv. downtime was 8.4%, Mechanical downtime 2.78%, Process downtime 1.5%, and Other downtime 2.34%
Present	23.8	6.87%	MONS 060277
Immed. Target	28.6	10%	Phase I of the Aroclor expansion will be mostly completed by August 12, 1964. At least a 40% rate increase will result. N.F.C. = $101,000. See items 13 and 14 of the Job List in the Appendix.
Long Range (1-3 yrs)	39.0	8%	Phase II of the Aroclor expansion will be initiated by parts as needed. N.F.C. = $120,000. See item 15 of the Job List in the Appendix

Expansion, Phase I, Chlorination

The Phase I expansion will be completed by 8-12-64. The actual capacity of the chlorination step will be at least 40% greater. The following items will be installed:

a. 4 air-cooled heat exchangers (1.1M BTU/hr.)
b. 4 larger Mark II Durco circulation pumps (250 gpm at 100' head)
c. Chlorine feed control (by batch temperature)
d. Chlorine feed totalizer for each chlorinator
e. Radiation Specific Gravity recorder for #4 chlorinator (to be installed by 9-1-64). See item 13 of the Job List in the Appendix.

Expansion, Phase I, Distillation

An integral part of the Phase I expansion consists of three separate projects as follows:

a. Convert the present 3-stage jets from condensing to 2-stage non-condensing. This will eliminate a costly production problem and help avoid an increase in work force. This project will be completed by 8-15-64. See item 10 of the Job List in the Appendix.

b. Project 8731 has been approved to install a larger pump (250 gpm 120' head) and a larger coil (3") in #2 still system by 9-10-64. The purpose of this project is to eliminate a maintenance problem and downtime. The still capacity will also be increased. #1 still will be similarly converted at a later date as the need dictates. See item 12 of the Job List in the Appendix.

c. A job will be taken out to evaluate the need for improved earth filtering facilities. If justified, the present facilities will be redesigned. This will be done by 10-1-64. See item 13 of the Job List in the Appendix.

Expansion, Phase I, Handling & Storage

A. Three 20,000 gal. finished product tanks will be installed by 9-15-64 as replacements for 3-15,000 gal. underground storage tanks at a cost of $92,000. The additional storage volume will be sufficient for a 40% increase.

The following projects listed below will eliminate some of the time-consuming operations of the "B" operator and packer. They will also help minimize any overtime work required to handle the increased capacity.

a. Install high-speed drum-off facilities.
b. Improve loading facilities at the docks.
c. Install metering and control equipment to up-grade blending facilities. Design packages will go to P & S by 10-15-64 presuming the estimates are approved. See item 14 of the Job List in the Appendix.

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Expansion, Phase II

A radiation specific gravity recording and controlling instrument will be

installed by 9-1-64 on #4 chlorinator as an experimental unit. Closed loop chlorination-level control should be a reality by about January, 1965. Phase II of the expansion program can then be initiated as the need dictates to increase the rate by 10.4M lb./yr. for a total average Aroclor rate of 39M lb./yr. The following items are part of the Phase II proposal:

a. Put 4 chlorinators on continuous chlorination: (see explanations below)

The obstacle involved in putting 4 chlorinators on continuous cascade operation is that 1242, 1248, 1254, and 1260 Aroclor are produced at WGK in about equal portions. Changing products in the chlorinators with continuous operation is no problem in going up scale from 1242 to 1248, etc. However, coming down scale produces about 600 gal. of crude Aroclor mixtures. No. 5 chlorinator can be operated batch-wise to produce 1260 Aroclor out of this mixture. A small biphenyl mix tank, a charge tank, and piping changes are all that will be necessary to convert to continuous chlorination. The radiation instrument will be used to control chlorination level (sp. gr.) in a closed loop system comparable to Anniston's installation. See item 15 of the Appendix.

b. Increase still capacity:

The #1 still can be converted to a larger pump and furnace coil, the same as #2. Larger burners will also be installed if more capacity is needed.

c. Increase intermediate and final storage capacity:

Storage capacity will be critical and two more 20,000 gal. final product storage tanks will be needed. Two intermediate storage tanks, 15,000 gal. each, will also be needed and can be used for aging the crude product.

d. Improve loading facilities:

A new loading dock station may also be needed as the trailer business increases. The chlorine supply line will have to be cleaned or renewed, and the biphenyl unloading operation will have to be improved time-wise.

B. Quality

Summary

Test	1242 Electrical Grade Aroclor Spec. or Std.	1963 or Historical	Present	Target
1. Resistivity (ohm-cm)	500×10^9	570×10^9	2700×10^9	1110×10^9
2. Power Factor	None	0.41	0.14	0.10
3. Hydrolysis Stability (ppm Cl^-)	1.0	0.41	0.51	0.25
4. Monsanto Stability (ppm Cl^-)	0.40	0.31	0.29	0.15
5. Thermal Chem. Chloride Stability (ppm Cl^-)	0.75	0.70	0.55	0.40

Aroclor specs, are generally very high and often difficult to attain. There

are indications that Monsanto customers would prefer even high quality Aroclor. It appears that Aroclor with higher stability and power factor will be needed.

Aroclor presently produced at WGK meets specs, but Anniston's Aroclor appears to be more stable by Munch and Hydrolysis stability tests. Results of thermal chemical chloride stability tests and Power Factor tests appear to differ between the two laboratories. All other quality tests indicate WGK is producing Aroclor comparable to Anniston, with a possible advantage to WGK in resistivity.

WGK Aroclor stability will be improved to meet Anniston's quality by 10-1-64. The lab is working to resolve analytical discrepancies to help pin-point what changes in operations are needed. Aroclor stability can be affected by:

a. Chlorination temperature.
b. Catalyst suspension, concentration and depletion.
c. Circulation and/or agitation.
d. Sulfate impurities in chlorine feed.
e. Crude Aroclor aging.
f. Cleanliness of chlorinator (also affects mixing).
g. Distillation boil down and entrainment.

Hydrogen Chloride Quality

Brink Mist Eliminators were installed in the off-gas off each Chlorinator on June 10, 1964 to prevent Aroclor carryover. The Aroclor carryover was eliminated, but the HCl off-gas is still contaminated with biphenyl. A cooler and scrubbing system has been designed to solve this problem. The total cost is $10,000. A savings of $5,000/yr. will result plus the savings of reduced downtime for Dept. F-218.

Improvement Plans

The following is a plan for improving Aroclor quality in general and specifically stabilities by 10-15-64:

1. At the completion of the expansion installation on 8-12-64 samples will be taken to check catalyst concentration (0.03% minimum) at different times during a chlorination cycle. If a problem is found to exist it will be solved as follows:

   a. Write an amendment to add extra catalyst.
   b. Use a different method to slurry and suspend the catalyst in the charge
   c. Use the same chlorinator packing Anniston uses.
   d. Evaluate any differences in catalyst produced by different manufactures

2. Compare temperature profiles of WGK's and Anniston's chlorinators, and evaluate differences by 10-1-64.

3. Evaluate the degree of boil-down of the stills and entrainment compared with Anniston. This can be done by analyzing the montars from the stills. Correlate these results relative to Aroclor stabilities by 10-15-64. Also run a profile study of stabilities on still fractions.
4. If the Aroclor quality has not been significantly improved to meet the objectives by this time a lab testing program will be set-up to study the

following variables affecting Aroclor quality in the plant:

a. Chlorinator circulation rate, basket design, packing and sparger design.
b. Aging of crude Aroclor.
c. Present filtering techniques.
d. A study to determine if raw biphenyl, low or high boilers, and special isomers are related to Aroclor stability.

C. Yields

Standard Aroclor yields are set at 93.49% of theory on Biphenyl. The % of theory on Biphenyl was 96.5% for 1963. The YTD yield as of May, 1964 is 97.4%. The yield target has been set for 97.5% for 1964, for a yield increase of 1%. This increase will come primarily from the installation of mist elimimators in the chlorinator off-gas lines (item 5 in the Appendix). This project was installed 6-15-64. A study will be made to determine whether reject samples and line flush out material can be used for non-electrical grade Aroclors.

Process Efficiency is defined as -

$$\frac{\text{lbs. Aroclor Produced + lbs. HCl Produced}}{\text{lbs. Biphenyl Used + lbs. } Cl_2 \text{ Used}} \times 100 \quad \% \text{ Efficiency}$$

This is a very good overall measure of the yields of products and raw materials. The P.E. for 1962 was 87.61%, 1963 was 85.49%, and currently is running 92.05%. The target for 1964 was set for 92.5% and the long range target was set at 93.0% for P.E.

D. Costs

1. Aroclor cost was $7.048/cwt in 1962, $6.884/cwt in 1963 and $6.451/cwt in 1964 through June. The cost will be further reduced to 6.101/cwt at a production rate of 28.6M lbs./yr. for a total savings of $100,000/yr. by 8-3-64, making a savings of $.350/cwt. (Item 13 in the Appendix). The Capacity Increase savings, Phase I and Phase II, are predicated on sales equalling production capacity. Phase II will be completed by August, 1965, if approved, and a production rate of at least 39.0M lbs./yr. of Aroclor will be possible. This rate will reduce Aroclor costs to $5.844/cwt and save $100,000/yr. A grand total of $210,000 can be realized at the completion of Phase I & Phase II of the capacity increase of the short and long range Process Improvement Plan, presuming capacity sales.

2. The Brink Mist Eliminators on top of the Chlorinators, part of Phase I, have been installed. This item is a part of the Cost Improvement Plan and produces savings of $10,000/yr. See item 5 of the Appendix.

3. The design package to revise the still jets was issued on 6-11-64. This project will save $5,000/yr. in steam usage and rate improvement and is a part of Phase I as well as a part of the Cost Improvement Plan. See item 10 of the Appendix.

4. Increased chlorinator circulation and cooling is a CIP item and will produce rate savings of about $100,000/yr. This Phase I project will be installed by August 12, 1964. See item 13 of the Appendix.

E. Pollution & Corrosion

1. A project was installed in 1959 to eliminate the HCl air pollution originating in the blow tanks. It has not been made to work up to April, 1964. This project was repaired and made operative by 4-15-64.

2. A study will be made of the Aroclor vapor and biphenyl vapor losses from tank vents. These fumes could contribute to air pollution and corrosion problems. Most of these vapors can be eliminated at a small cost.

F. Safety

1. A design package was out by 3-1-64 to install a Chlorine superheater to insure that no liquid Chlorine will get into the Chlorinators. This project was installed by 4-24-64 and is operating. Many safety features will be included in the Phase I & II expansions to protect equipment and personnel. The dept. has not had a lost time accident since January 28, 1948.

G. Long Range Plans & Studies

1. As part of the Long Range Plan the possibility of a rate increase by new chlorinator designs should be investigated. It is recommended that continuous stirred reactors, multisectioned stirred reactors, and tubular reactors be investigated. A substantial rate increase and cost reduction could result from a new design of the distillation system with controlled skin or boundry temperatures to prevent product decomposition.

2. The R & D Section recommends an evaluation of the following to increase rate and improve quality:

a. Chlorination with a new catalyst that will yield a product of higher quality. More catalyst
b. Vapor phase chlorination reactions. This could lead to tubular reactors with higher quality and rates.
c. Liquid Chlorine use in chlorination reaction. Better quality will be investigated.
d. A column for earth-treating Aroclor. Evaluation of better methods of earth-treating is needed.
e. Exchange samples of Aroclor with Anniston on a regular routine basis to check analytical results.

3. Other studies that are further recommended are:

a. Elimination of air blowing.
b. Longer residence time for crude Aroclor at elevated temperatures in the presence of HCl and catalyst.
c. Addition of lime to blow tanks instead of the stills.
d. VPC methods of Aroclor analysis and isomer identification.
e. Studies to determine how Aroclor quality, rate and costs are affected by higher pressure and temperature chlorinations.

f. Air-cooled condensers in the still system.
g. Studies to determine the need for a column in Aroclor distillation for isomer selection.

II. PYDRAULS AND PYRANOLS

A. Pydrauls and Pyranols are mixes of Aroclor and other components. The major part of the mix is Aroclor in most cases; therefore, rate, quality, yields, costs, etc. have been covered under Aroclors. A study will be made of mixing, blending, earth treating, and filtering to up-grade the technique, quality and rate. The blending of Pyranols is a Cost Improvement Item. An estimated $6,000/yr. can be saved by a close control of the sp. gr. of the Aroclor, TCB and TTCB used in the Product. See item 16 in the Appendix.

Automatic control equipment to meter the components that comprise the product mix will be installed by December, 1964. This will release an operator to assist in other work to increase the dept. rate. See item 14 of the Appendix.

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APPENDIX III

Priority	PTS Job No.	JOB TITLE	DESCRIPTION	SPECIFIC OBJECTIVE	Job Status & Remarks	Est. Pet $ Savings P.T.	Capital $ Required	E.D.C.	PTS Man-days Req'd.	Probability of Success
1	3134	Inert Finished Product Tank	Install Nitrogen system	Maintain high Elect. Grade Quality by preventing Product degrading.	Project completed 5-10-64	Quality	800		10	95%
2	3203	Install Oven	Electric Oven to heat-treat Attapulgus earth.	Quality improvement by activating earth.	Project completed 2-20-64	Quality	2000		9	75%
3	3202	Install Brink Mist Eliminator in Cl_2 Line	Filter system to eliminate impurities in Cl_2 system.	Improve Quality by impurity elimination.	Project completed 4-24-64	$5000 - Quality	2600		10	95%
4	3205	Install Cl_2 Vaporizer	4" Chlorine Vaporizer in Cl_2 Line.	Safety protection for chlorinators	Project completed 4-24-64	Safety	3800		10	99%
5	3126	Improve HCl Off-Gas Quality	Filter impurities out of off-gas.	Stop biphenyl and Aroclor carryover.	Installation started 6-6-64	10,000 Quality	12,400	8-12-64	47	90%
6	3189	Redesign Chlorinator Catalyst Basket	Change size of chlorinator basket.	Improve quality by improved Chlorinator circulation.	Package to P & S 6-5-64	Quality	Earnings Expense 2300	9-1-64	15	80%
7	3166	Prepare Tank Layout	Layout, no. tanks, size, and material of construction.	Plan for an organized department layout	Completed 4-25-64	To be determined.	0		10	90%
8	3235	Redesign Chlorine Sparger	Stainless steel, Sch. 80 ring sparger.	Improve Quality	Package to P & S 7-17-64	Quality	300	9-1-64	5	90%
9	3222	Replace 3 Product Tanks	3-15,000 gal. product tanks being replaced by 3-20,000 gal.	Rate increase by extra storage capacity	Construction started 7-13-64	Equipment Replacement	92,000	9-15-64	30	99%
10	3251	Replace Still Jets	Alter 3-stage cond. jets to 2-stage non-condensing	Rate improvement by eliminating operating problem and downtime.	Pkg. to P & S 6-11-64	5,000	3000 Earnings Expense	9-1-64	10	90%
11	3198	Improve E.C. Aroclor Quality	Isolate stability problem and solve.	Quality improvement	Job appr'd 2-3-64			8-1-64	25	80%
12	3229	Replace Still Coil	Replace 8" coil with 6" coil to match new installation of larger pump project 8791 E.D.C. - 9-10-64	Rate increase and eliminate downtime.	Pkg. to P & S 4-16-64	To be determined.	2600 Earnings Expense	9-10-64	14	90%

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13	8-510 O.E.	Increase Aroclor capacity Phase I	Install: 4 air-cooled heat exchangers on chlorinators, 4-10 H.P. pumps 250 gpm 100' head, Radiation Sp. Gr. recorder, Chlorine control valves (5) and integrator, etc.	Rate increase from 20.44 lb./yr. Cost Improvement	Under Construction	100,000	95,000	8-12-64	20	99%
14		Improve mixing, filtering and loading facilities.	1. Shut-off control valves at drum-off and loading stations. 2. Metering and control equipment at Pyranol mixing stations. 3. Replace 30" Sparkler filter.	Insure rate increase without addt'l.	Est. will be about 10-1-64	To be determined	6,000	11-30-64	15	90%
15		Increase Aroclor Capacity Phase II	1. Alter piping to put 4 Chlorinators on series continuous Operation. 2. Install biphenyl head tank, mix tank and metering system. 3. Increase still capacity on #1 still, (Same as #2) 4. Improve drum-off fac. 5. Add line to blow tank. 6. Install 2-15,000 gal. aging tanks. 7. Install 2-20,000 gal. stg. tanks.	Rate Increase Cost Improvement	Est. will be out by 2-1-65	100,000	120,000	5 mo. After approv'd	30	90%
16		Alter Pyranol Mix Procedure	Control component sp.gr. more closely	Cost Improvement	Open job by 8-15-64	6,000		9-1-64	10	85%
17	Evaluation of rate variables		1. Lab R & D will evaluate catalysts, vapor phase reaction, liquid phase reactions, and column earth treating.	Rate and Quality	Job will be opened by 12-1-64	To be determined	15,000	6-1-65	10	70%
18	Evaluate design changes of chlorinators and the dis-		1. Evaluate stirred reactors and tubular reactors, etc. 2. Consider designs to avoid high skin temperatures and product degradation.	Rate and Quality	Long Range next 2-3 yrs.	To be determined	To be determined	1966	30	80%