PROCESS DESCRIPTION

SOLID AROCLOR MANUFACTURING FACILITIES

PROJECT CEA 2080

T A B L E O F C O N T E N T S

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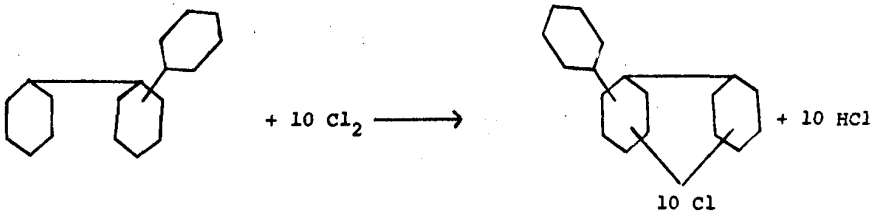
Section I - Synopsis of Aroclor Process

Aroclor is a tradename used to designate the chlorination products of biphenyl, biphenyl high boilers or a mixture of the two. Solid Aroclors are produced by chlorinating the biphenyl or Santowax R to a high level of chlorine content. The process here described is for the Solid Aroclor system using Santowax R or a mixture of biphenyl high boilers as the starting material. They are identified by a four digit number. The last two digits represent the chlorine content (percentage by weight) and the first two numbers represent the chlorine condition. If the first digit is "5," it signifies that the Aroclor has been made from Santowax R. If the second digit is "0," the product has not been distilled. If it is "4," the product is a distilled grade. As an example, Aroclor 5460 is a distilled chlorinated terphenyl containing 60% chlorine.

The first process step in the manufacture of Solid Aroclors is a chlorination step. Santowax R and chlorine gas in the presence of ferric chloride catalyst react to form a chlorinated aromatic compound. Hydrogen chloride gas is liberated during the reaction and either recovered or drowned in a scrubber and sewered. The main reaction is a simple replacement of hydrogen by chlorine, but the product of the chlorination contains trace amounts of halogen containing by-products which are less stable than the direct ring-substituted products. Many isomers are formed. A schematic representation of Santowax R chlorination is as follows:



Terphenyl Chlorine Aroclor 5460 Hydrogen Chloride

Molecular Weights:		
	Terphenyl	= 230.3
	Chlorine	= 70.9
	Aroclor 5460	= 574.8
	Hydrogen Chloride	= 36.5

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The second process step is aeration. The material is held at a high temperature, 200°C, and then blown with dry air in an aeration tank to remove trace amounts of HCl gas and other gaseous impurities.

The third process step is a flash distillation. This is carried out under vacuum conditions at an absolute pressure of 5-10 mm at the still pot and a temperature of 260°-360°C. Heat for the distillation is supplied by an external source. The distillation must be carried out in the presence of lime. The residue product, which contains lime, ferric chloride, and tars, is generally drawn off to drums for discard or for sale as Montar.

The fourth process step is flaking. The distilled Aroclor is flaked on a drum flaker and the flakes bagged or placed in fiber drums for shipment to our customers.

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Section II - Terphenyl Feed Tank

A. Routine Operation

1. Design Consideration

a. $FeCl_3$ is mixed with Santowax R in an agitated tank. Minimum catalyst concentration is 0.13% by weight or 15 lbs/charge.

b. To provide the correct charge to the chlorinator, the tank is set on a hopper scale.

2. Terphenyl Feed Tank Operation

a. Check that steam is on the coil in the tank and the temperature controller is operational. Set at 150°C in automatic.

b. Close valve under feed tank.

c. Set scale pointer to 11,200 lbs and start Santowax R charge pump. At this weight, the charge valve will shut off and an alarm will sound. The charge valve will not open if the transfer pump is operating.

d. Start agitator.

e. Add 15 pounds of ferric chloride.

f. Charge to chlorinator is made on demand. When tank is empty, pump will stop and an alarm will sound.

B. Safety Features

1. A temperature controller controls the temperature in the tank by throttling a steam control valve. This will prevent the tank from overheating.

2. The charge valve to the tank cannot be opened when the transfer pump is running. The pump cannot be started if the charge valve is open.

3. If the weight in the tank reaches the first set point, the Santowax R charge valve will close and an alarm will sound. If the weight exceeds the normal charge, a switch on the scale set at 12,000 lbs will shut the Santowax R charge valve and sound an alarm.

4. A steam jacketed vent with flame arrestor is installed on the tank.

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C. Emergency Shutdown

1. Shut off steam to steam coil.

2. Shut down agitator.

D. Control Loops, Interlocks and Alarms

1. There are two major control loops in this system.

a. Terphenyl Feed Tank Temperature Control - TIC-101

The function of this loop is to provide temperature control for the Santowax R in the mix tank. This is accomplished by measuring the Santowax R temperature and controlling the steam supply to the coil through a control valve. Set point is 150°C.

b. Terphenyl Feed Tank Weight Control - WV-101

The function of this loop is to permit a fixed charge of Santowax R to pass through a charge valve into the feed tank. As soon as the correct weight is attained, the valve will close and an alarm will sound.

2. Interlocks

a. If the feed tank overfills, a second cutoff on the scale will sound an alarm and attempt to close the charge valve.

b. When the feed tank is empty, the charge pump to the chlorinator will stop and an alarm will sound.

c. When the chlorinator charge pump is operating, the charge valve cannot be opened. Likewise, when the charge valve is open, the chlorinator charge pump cannot be started.

3. Alarms

The following alarms exist through the system:

a. Correct charge in the mix tank.

b. An overcharge in the mix tank.

c. When the mix tank is empty and the chlorinator charge pump stops.

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Section III - Chlorinators No. 10 and No. 11

A. Routine Operations

1. Design Considerations

a. Based on the demonstrated Solid Aroclor chlorinator system at Anniston. The chlorinator was designed 1) at the same apparent vapor velocity of the No. 9 chlorinator unit at a demonstrated rate of 10M lbs/yr and 2) the material level at least equal to the level in No. 9 chlorinator.

b. Allowance was made for a volume expansion of 50% with a minimum of 36 inches for vapor disengaging at the end of the chlorination.

c. The heat removal system is based on a heat evolution of 510 BTU/hour/pound of chlorine added. Normal evolution at the input rate of 3M pounds/hour of chlorine is 1,530M BTU/hour. With a radiation and convection loss of 735M BTU/hour, the net heat evolution is 795M BTU/hour. Design rating of the external Therminol heat exchangers is 1,400M BTU/hour. This external heat removal system is similar to the system on No. 9 chlorinator which has worked successfully for the past 5 years.

d. The flow of chlorine to the chlorinator is controlled by a flow controller which allows manual adjustment of chlorine feed rate with automatic control by means of a batch sequence controller. This allows the batch to be controlled as follows:

1) Three feed levels of chlorine input.

2) Eight time periods for the regulation of batch temperatures since the batch temperature has to be increased during the chlorination period to prevent high pumping viscosities. The batch temperature will vary between a beginning temperature of 160°C to an ending temperature of 250°C.

e. The system is designed so that hot Aroclor can be put on the following items:

1) Circulating lines at the chlorinator.

2) Chlorinator coolers.

Normally, hot Aroclor will be kept on the circulating lines at the chlorinators to prevent blockages.

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f. Entrainment separators are installed at the top of each chlorinator to prevent Aroclor from being lost from the chlorinator. The Brinks-Monsanto unit will eliminate 99% of all particles 3 microns and smaller from the vapor stream and return the entrained liquid to the chlorinator.

g. Chlorine sparger design is based on a chlorine velocity of 50 feet per second, a chlorine rate of 3,000 pounds per hour with 3/16 inch hole size.

2. Chlorinator Operation

a. Check that the 2 inch chlorine valves on the header at the chlorine distributor are closed.

b. Align vent valves to the muriatic acid area.

c. Check that hot Aroclor is on the transfer line from the terphenyl charge tank and that steam is on the tracer around the transfer pump.

d. Check that the external Aroclor system is operating in the normal manner. Water should be going into the Aroclor coolers (Item 116, or Item 123). Pumps (Item 115 or 122) should be circulating Therminol through the chlorinator coolers (Item 106 or 119).

e. The control system should be set for the desired chlorinator program. For Aroclor 5060, settings should be:

1) For chlorine input, flow recorder controller:

First Hour	1,500 lbs/hour
Second Hour	2,000 lbs/hour
Third Hour	3,000 lbs/hour
Subsequent Hours	3,000 lbs/hour

Note: This is based on 100% available chlorine.

2) For temperature control, temperature recorder controller:

First Hour	190°C
Second Hour	200°C
Third Hour	210°C
Fourth Hour	220°C
Fifth Hour	230°C
Sixth and Seventh Hours	240°C
Eighth and Nineth Hours	250°C
Tenth and Eleventh Hours	255°C

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f. Set the chlorine integrator for 80% of the calculated input, which is 24,400 pounds. By setting the integrator to 80% of the calculated flow, an alarm will sound giving the operator a signal when the batch is 80% chlorinated. The chlorine integrator will continue to totalize the flow of chlorine into the chlorinator until the batch is complete.

g. Align valves from terphenyl feed tank to chlorinator and transfer Santowax to chlorinator.

h. Set selector switch of the temperature controller (TRCA 106-1 or TRCA 119-1) to automatic position with set point at 190°C.

i. Align chlorinator valves and circulate mass through external cooler.

j. Align chlorinator valves in chlorine line to chlorinator and set flow controller (FRC 104-1 or FRC 117-1) to the manual position. Set flow controller to 1,500 pounds/hour. Open chlorine valves at the inlet to the sparge pipe.

k. When the chlorine feed stabilizes at 1,500 pounds per hour, put flow controllers in automatic with set point at 1,500 pounds/hour.

Note: Chlorine control valve should be open before the manual valves are opened.

l. Take softening point measurements at regular intervals during the chlorination. As soon as the batch reaches the finished softening point, then:

1) Shut off the chlorine hand valves.

2) Set temperature recorder to manual. Leave set point at 255°C until batch is transferred, then reset to 190°C.

3) Align valves for transfer to the blow tank.

m. A density recorder is provided in the chlorinator circulating line to record the density of the crude product. Density correlates with the softening point of the crude Aroclors.

B. Safety Features

1. A high temperature alarm is set at 275°C on the individual chlorinators to prevent excessive carryover of material into the HCl off-gas header. Temperatures above this will cause excessive carryover of Santowax R or crude solid Aroclor.

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2. A low temperature alarm is set at 120°C on the individual chlorinators to prevent a too low starting temperature for the process.

3. If the chlorinator temperature gets too high, a high temperature switch will cut off the flow of chlorine to the chlorinator. Likewise, if the circulating pump into the chlorinator coolers shuts down, the chlorine flow into the chlorinators will be cut off.

4. The circulating loop through the chlorinator coolers contain the control system for removing heat of reaction. These units (TRCA 106-1 or TRCA 119-1) will sound an alarm if the temperature in the circulating loop is 120°C or 275°C.

5. The circulating Therminol loop through the water Therminol exchangers contains flow controllers (FICA 115-1 or FICA 122-1) which control the flow of Therminol to the water Therminol exchangers. In the event the flow stops, an alarm will sound. Normal flow of Therminol is 250 gallons per minute. A temperature control system on the water Therminol exchangers will control the output temperature of the Therminol coming back to the chlorinator coolers. High temperature for the Therminol leaving the water Therminol exchanger is 90°C. Low temperature for Therminol leaving the water heat exchanger is 50°C.

6. Rupture discs are installed on each chlorinator to protect against over-pressurization, but not failures which may result from explosions. Set pressures for the rupture discs are 50 psig.

C. Emergency Shutdown

1. Close block valves to the chlorine distributor to the chlorinators. Reset chlorine feed control valves to zero with instrument in manual.

2. In the event of a prolonged shutdown, greater than 2 hours, the batch should be circulated through the chlorinator cooler and Therminol put on the Therminol cooler in order to maintain a minimum batch temperature of 150°C.

D. Control Loops, Interlocks and Alarms

1. There are five major control loops in this system.

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a. Density Recorder, DR-104-4, 117-4

The function of this loop is to provide an estimate of what the softening point of the distilled product will be. A correlation exists between density and softening point which may eliminate the time-consuming softening point determination.

b. Chlorinator Flow Control and Totalizer, FRC-104-1, FQS-104-2, FRC-117-1, FQS-117-2

The function of this loop is to control the chlorine flow to the chlorinators and regulate the rate of chlorination. This is done by measuring the chlorine flow with an orifice and controlling this flow with a control valve in the chlorine feed line. This system can be operated manually or automatically. The flow of chlorine is altered in three steps, 1,500 lbs/hour for the first hour, 2,000 lbs/hour for the second hour, and 3,000 lbs/hour for each of nine subsequent hours. The integrator readout is total pounds of chlorine. This instrument has two dials, one is set at 80% of total batch poundage of chlorine and figures are not affected by increasing figures on the second dial which indicates the total flow. When the integrated flow equals the pre-set flow (80% of total), an alarm rings in the control room. Totalizing continues until chlorine flow stops. A reset button on the integrator returns the integrated flow dial to zero. The chlorinator circulating pump must be running and normal temperature must exist in the chlorinator before the flow control valves can be opened. A high chlorinator temperature, 275°C, or circulating pump shutdown automatically stops the flow of chlorine.

c. Chlorinator Temperature Control - TRCA-106-1, TRCA-119-1

The function of this loop is to provide temperature control for the batch in the chlorinator. This is done by measuring the temperature of the crude Aroclor in the circulation line at the discharge of the Therminol heat exchanger and controlling the flow of cool Therminol to the heat exchanger. The temperature system has a low temperature alarm at 120°C, a high temperature alarm at 275°C. Chlorination temperature is controlled through a series of discreet time dependent steps. This is accomplished through a controller mounted on the panel board and pre-set with the control conditions.

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d. Therminol Flow to Chlorinator Cooler, FICA-115-1, FICA-122-1

The function of this loop is to control Therminol flow to the Therminol coolers. This is done by measuring flow with an orifice plate and splitting the flow into two streams. One stream is modulated by a temperature control valve. The other stream, contains the flow control valve, which is modulated by a control signal from the temperature controller and carries the difference in flow between set point and fresh stream. In this way, the total flow always continues through the Therminol water heat exchanger. If the flow is too small, an alarm will sound. Set point is 250 gpm. Normal flow is 300 gpm.

e. Therminol Temperature Control, TICA-116-1, TICA-123-1

The function of this loop is to control the temperature of Therminol leaving the water-Therminol heat exchangers. This is done by measuring the temperature out of the cooler and controlling the flow of tower water with a control valve in the tower water line to the heat exchanger. An alarm will sound if the temperature in this line is 90°C or 50°C.

2. Interlocks

a. If the temperature in the chlorinator at the sparge ring reaches 260°C, the chlorine control valve will close and an alarm will sound.

b. If the chlorinator circulating pump motor shuts off, the chlorine control valve will close and an alarm will sound.

3. 3. Alarms

The following alarms exist through the system:

a. High temperature at the chlorine sparge ring, 275°C.

b. High temperature in the chlorination circulation mass, 275°C.

c. Low temperature in the chlorination circulation mass, 120°C.

d. Low flow of Therminol through the chlorinator-cooler and water-Therminol heat exchanger, 250 gallons per minute.

e. High outlet Therminol temperature from water-Therminol heat exchanger, 90°C.

f. Low temperature of Therminol out of water-Therminol heat exchanger, 50°C.

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Section IV - Intermediate Storage and Blow Tank

A. Routine Operations

1. Design Considerations

a. The blow tank is designed to accommodate two batches from the chlorinator. This amounts to 4,320 gallons. A free board of 2,166 gallons has been allowed.

b. The tank is equipped with an air sparger system so that trace amounts of hydrogen chloride can be removed before a charge is made to the still system. The amount of air that will be blown through the batch is 300 pounds.

c. A sparger pipe is in the tank to distribute the air through the batch. It is designed for a rate of 50 ft per second through the sparge holes.

2. Blowing Tank Operation

a. Check that hot Therminol is on the plate coils of the blow tank. Normally, once this is energized, it will remain energized. Temperature is set at 240°C.

b. Check that hot Therminol is on the transfer line from the chlorinator transfer pump to the blowing tank.

c. Align valves in transfer line from Chlorinator No. 10 or No. 11 circulating pump to blowing tank.

d. Energize scrubber system for blowing tank by opening water valve at the S&K eductor.

e. Check that valve at bottom of blow tank is closed. Transfer batch from chlorinator to blowing tank.

f. As soon as the batch is transferred, realign valves at the chlorinator and shut down the transfer pump.

g. Start air blower and open valve into the blowing tank sparger. Sparge for 60 minutes.

B. Safety Features

1. A rupture disc is installed on the blowing tank to protect against over-pressurization. Set pressure for the rupture disc is 50 psig.

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2. The blowing tank has a level indicator to show the level of material in the tank. An alarm will sound when the level reaches 90%.

C. Emergency Shutdown

1. Shut down the blow tank air pump and the hot Therminol input to the heating coils.

D. Control Loops, Interlocks and Alarms

1. There are two major control loops in this system.

a. Blowing Tank Level Indicator - LIA-125-2

The function of this loop is to indicate the blow tank level in the control room and in the field. It also alarms on high level. This is done by dip tubes which extend into the tank. These tubes are purged with air and the differential pressure, sensed by a d/p cell, is transmitted to a locally mounted and panel mounted receiver gauge graduated 0 to 100%. A high level will sound on the annunciator cabinet when the level is 90%.

b. Blowing Tank Temperature Control - TIC-125-1

The function of this loop is to control the temperature of crude Aroclor 5060 in the blowing tank during the tank filling, pump-out and hold periods. This is done by measuring the temperature of the batch in the tank and controlling the flow of Therminol into the plate coils on the tank through a control valve. Set point is 240°C.

2. Interlocks

a. An interlock exists between the blowing tank transfer pump and the still pot. If the level in the still pot reaches a higher than normal level, a swtich in a level device at the still pot will prevent the transfer pump from starting.

3. Alarms

The following alarm exists in the system:

a. High level in the blowing tank, 90% full.

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Section V - Off-Gas Purification

A. Routine Operation

1. Design Considerations

a. HCl gas from Chlorinators No. 10 and No. 11 will be cooled from 225°C to a temperature of 130°C in a gas cooler. Entrained Santowax and Aroclor, condensed by the gas cooler, will be stored in an off-gas storage tank. The cooled gas will pass into the transfer line to the HCl purification plant.

b. HCl gas can be vented through the blow tank into the local scrubbing system.

c. It is expected that the tank will be pumped empty at approximate five-day intervals.

2. Off-Gas Storage Tank Operation

a. Check that steam is one the plate coil of the storage tank and the temperature controller is operational. Set at 130°C in automatic.

b. Close valve under tank.

c. Align valves to circulate Therminol through air cooler, off-gas condenser, and return to surge tank.

d. Set the Therminol controller in automatic with set point at 130°C.

e. Start the Therminol circulation pump.

f. Align valves to direct HCl gas from the chlorinators into the off-gas condenser.

g. Align valves to direct HCl gas to the HCl department.

h. Check level in the off-gas storage tank. The material can be pumped to the existing terphenyl charge tank by aligning valves and starting pump. The tank will hold 2,000 gallons of material.

B. Safety Features

1. A temperature controller is located at the tank to control the temperature in the tank and prevent the tank from overheating.

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2. A level instrument is located at the tank to indicate level of material in the tank.

3. A rupture disc, with a bursting pressure of 50 psig, is located on the off-gas storage tank.

C. Emergency Shutdown

1. Close the chlorine valves to the chlorinators. This will prevent HCl gas from entering the off-gas condenser.

2. Shut down temperature control system.

D. Control Loops, Interlocks and Alarms

1. There are three major control loops in this system.

a. Off-Gas Storage Level Indication, LI-109-2

The function of this loop is to provide an indication of level of material in the off-gas storage tank. This is done by dip tubes which extend into the tank. One tube senses tank internal pressure, the other extends to the bottom of the tank. The dip tubes are purged with air, and the differential pressure is sensed by a d/p cell. The signal is transmitted to a locally mounted receiver gauge graduated 0 to 100% which indicates tank level in the field.

b. Off-Gas Storage Tank Temperature Control - TIC-109-1

The function of this loop is to provide temperature control for the material in the off-gas storage tank. This is done by measuring the temperature and controlling the heat input by throttling a control valve in the steam line to the plate coils on the storage tank. Set point for controller is 130°C.

c. Off-Gas Condenser Temperature Control - TIC-111-1

The function of this loop is to control the temperature of the circulating Therminol to the off-gas condenser. This is done by measuring the Therminol temperature in the surge tank and transmitting a signal to a controller in the control room. The controller compares this signal with the set point and transmits a control signal to each of two positioners. One positioner is mounted on an air cooled heat exchanger and operates louvers, the second positioner operates a steam control valve in a steam line to heating coils of the surge tank. Set point for the controller is 130°C.

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2. Interlocks

There are no interlocks in this system.

3. Alarms

There is a low flow alarm which is activated if the Therminol circulation pump motor stops.

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Section VI - Distillation

A. Routine Operations

1. Design Considerations

a. Time cycle:

Charge	0.5 hours
Heat-up	3.0 hours
Distill	7.5 hours
Empty	1.0 hours
Total	12.0 hours
Distilling Rate	5,050 lbs/hour
Capacity for Aroclor 5460	5,050 lbs/hour x 7.5 hours/ba x 8,750 hours x 72.5% divided by 12.0 hours = 20M lbs/year

b. The charge to the still pot is 4,180 gallons. The still pot has a capacity of 6,550 gallons, which leaves a free board of 2,370 gallons or 38 inches.

c. Heat for distilling is provided by an external gas-fired heater. Calculated loading for the external still heater is:

Heat-up	1.4M/BTU/hour
Vaporize	1.1M/BTU/hour

The design absorption rating of the heater is 2.0M/BTU/hour. The batch will circulate through the heater coil at 250 gpm.

d. The distillation rate is controlled by a flow controller mounted on a panel board and controlling the gas flow to the heater.

e. The calculated vapor load for the still vapor condenser is 5,050 lbs/hour. The design loading is 5,560 lbs/hour. The heat balance for the condenser is:

Condense	556,000 BTU/hour
Cool	695,000 BTU/hour
Total	1,251,000 BTU/hour

The condenser was designed for a gas flow velocity of 159 feet per second, which is less than 50% of the critical velocity of 348 feet per second.

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f. Heat removal from the condenser is accomplished by circulating Therminol through the shell side of the condenser and cooling the Therminol in a water-Therminol exchanger.

g. Two batches will be distilled through the still system before Montar or residue is withdrawn from the still pot. Lime will be added to the still pot before each distillation.

h. The still receiver is designed to hold 4,100 gallons of finished material at a gravity of 1.5 at 200°C. This represents a yield of 98% on the still charge.

i. During distillation, the material in the still pot decomposes and HCl gas is formed. The ejector system is designed to handle an HCl gas load.

2. Still Operation

a. Align valves to charge from blowing tank.

b. Start blowing tank pump and charge 4,180 gallons into the still pot. This will leave 38 inches of free board for disengaging height. A high level cutoff is on the still and will shut off the transfer pump.

c. Add 400 lbs of lime directly to the still pot. Close still and still receiver.

d. Energize the steam ejector.

1) Close main valve in vacuum line to still above receiver.

2) Start steam to fourth stage. Start water into second barometric condenser.

3) Start steam to third stage and readjust water flow to second barometric condenser.

4) Start water into first barometric condenser. Start steam to second stage and readjust water into first barometric condenser.

5) Start steam to first stage.

6) Open water valve to the after-condenser and adjust to a point where no steam is escaping from the after-condenser vent.

7) Vacuum should pull down steadily to about 1 mm mercury absolute and hold steady.

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e. Align valves at still receiver from ejector to condenser.

f. Energize the Therminol circulating system to the condenser.

1) Align valves to circulate Therminol through the still condenser and water-Therminol exchanger and return.

2) Set TRC-131-1 at a temperature of 150°C.

3) Start the Therminol circulating pump.

g. Align valves in still pump line to circulate through external gas-fired heater and back into the still. Start pump.

h. Increase the flow of gas to the external gas-fired heater by adjusting the flow controller, FRCA-128-1. This is the control over the rate of distillation and also the heat-up rate of the batch.

i. When the still is under proper operating conditions, the following data can be expected:

1) Proper operating temperatures for Aroclor 5460:

Begin Distilling	End Distilling
260°C	355°C

Temperature Profile Through Heater

At Beginning	
Into Coil	200°C
Out of Coil	212°C
At End	
Into Coil	388°C
Out of Coil	400°C

2) Vacuum 5 mm mercury absolute at the still pot.

3) Distilling rate 5,560 lbs/hour.

4) Still condenser. Forward flow temperature at 155°C.

5) Still pump. Output pressure at 65 psig and flow at 250 gpm.

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j. As the distillation continues, the temperature in the still pot will rise and flow through the heater coil will remain steady. When the flow drops to 125 gallons per minute, an alarm will sound. This should be the time to cut the gas flow to the heater. As an additional aid, a cutoff switch will stop the flow of material through the coil when the level in the still pot reaches the bottom dish.

k. At the end of the distillation, the batch is checked for color and softening point and is transferred to the flaker hold tank. Check that space is available in the flaker hold tank before transfer is made.

l. Clear heater coil by opening vent valve in line at still pot and allowing vacuum to suck coil dry. The jet should be isolated from the still receiver when this is done.

B. Safety Features

1. A low flow through the external heater coil will activate an alarm.

2. A low gas flow to the external heater will sound an alarm.

3. If the level in the still pot is too high, the transfer pump from the blowing tank will not operate.

4. A rupture disc, with a bursting pressure of 50 psig, is installed on the still pot and on the receiver.

5. If the temperature in the still pot gets too high or too low, an alarm will sound.

6. A site glass has been placed in the return leg from the cyclone. Some flow is necessary for satisfactory operation.

C. Emergency Shutdown

1. Shut off feed to the still pot.

2. Shut off gas flow to the external heater.

3. Shut off still pot circulating pump and drain coil through heater.

4. Release vacuum by closing the block valve to the jet and venting the receiver or still pot.

D. Control Loops, Interlocks and Alarms

There are nine major control loops in the still pot system.

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a. Fuel Gas Flow to Still No. 5 Heater - FRCA-128-1

The function of this loop is to control the flow of fuel gas to the heater. This is done by measuring the gas flow with an orifice and controlling this flow with a control valve in the gas feed line.

b. Low Flow Still No. 5 Heater, Alarm and Shutdown - FIA-128-2

The function of this loop is to measure the circulating flow through the still heater coil and to shutdown the heater if the flow becomes too low. This is done with a target meter in the transfer line to the still heater. If the flow decreases below a previous set point, an alarm will sound and the main burner will shut down. The low flow alarm switch is set at 125 gpm.

c. Still No. 5 Heater Control BCA-128-9

The function of this loop is to provide a safe start-up and shutdown facility for Still No. 5 heater and to provide a safe, automatic heater shutdown in case of emergency. The complete details of this system are contained in the instrument function outline, Loop No. 1-BCA-128-9.

d. Still Pot No. 5 Level System - LS-129-3

The function of this loop is to prevent overcharging of the still pot and to alert the operator that the batch distillation has continued to a point that endangers the flow requirements of the still circulating pump. This is done by gamma radiation operating through the batch from a single source mounted at high level to activate the high-level switch. The low-level switch is mounted on the circular part of the bottom dish. The high-level switch will shut down the blow tank pump and extinguish the run light. The low-level switch will activate an alarm.

e. Still No. 5 Condenser Temperature Control - TRC-131-1

The function of this loop is to maintain the temperature of the Aroclor 5460 from the condenser at a suitable level. This is done by measuring the temperature in the outlet line from the condenser and controlling the cool Therminol flow to the condenser with a control valve. Set point for the controller is 150°C.

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f. Still No. 5 Receiver Temperature Control - TIC-132-1

The function of this loop is to control the temperature of Aroclor 5460 in the receiver during filling and pump-out to storage. This is done by measuring the temperature in the tank and controlling this temperature by throttling a control valve in the steam line to the tank coil. Set point for the controller is 130°C.

g. Still No. 5 Receiver Level Indication - LI-132-2.1/2.2

The function of this loop is to indicate the level of Still No. 5 receiver, both in the field and in the control room. This is done by a displacement-type level transmitter. A 0 to 100% dial indicates level in the field and a similar dial indicates tank level at the control panel.

h. Therminol Flow to Still No. 5 Cooler - FICA-140-1

The function of this loop is to control the Therminol flow to the water-Therminol cooler. This is done by measuring the Therminol flow with an orifice. One stream is modulated by a temperature control valve in the line to the still condenser. The other stream contains the flow control valve and carries the difference in flow between set point and the first stream. Normal flow is 200 gpm. An alarm is activated if the flow drops below a set point of 160 gpm.

i. Therminol Temperature Controller - TICA-141-1

The function of this loop is to control the temperature leaving the water-Therminol exchanger. This is done by measuring the temperature of the Therminol leaving the water-Therminol exchanger and controlling this temperature by throttling a control valve in the water line to the exchanger. An alarm will sound if the outlet Therminol temperature is too high or if the outlet Therminol temperature is too low.

High Temperature Alarm	-	90°C
Low Temperature Alarm	-	50°C

2. Interlocks

a. Low flow of circulating Aroclor through the external fired heater will shut the heater down.

b. Low fuel gas pressure, PS-128-10, 2.5 psig.

c. High fuel gas pressure, PS-128-11, 25 psig.

d. High furnace coil outlet temperature, ITSUI-128-6, above 800°F.

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e. Failure of pilot flame, DCA-128-9.

f. An electric power failure will shut the furnace down.

g. A high level in the still will shut the blow tank pump down to prevent overfilling.

h. A low flow to Still No. 5 condenser will cause an alarm to sound in the control room, 160 gpm.

i. A low or high-temperature Therminol stream leaving the water-Therminol exchanger will activate an alarm in the control room.

3. Alarms

The following alarms exist through the system:

a. A low flow of Aroclor through the external heater will stop the flow of fuel gas to the heater and sound an alarm.

b. A complete shutdown of the external heater.

c. High or low-temperature in Still Pot No. 5.

d. High temperature in the circulating loop through the external fired heater, above 800°F.

e. High or low temperature of Therminol from the water-Therminol exchanger.

f. Low flow of Therminol through the water-Therminol exchanger.

g. Low level in the still pot.

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Section VII - Still Heater

A. Start-up Operations

1. Design Considerations

a. The still heater is designed to provide enough heating for distilling and with a skin temperature low enough to prevent carbonization. Tests in the Anniston Lab on Aroclor 5060 show the following:

	Condition			
Temperature	11 Mins.	12 Mins.	15 Mins.	60 Mins.
437°C (819°F)	No Decomp.	No Decomp.	No Decomp.	No Decomp.
455°C (851°F)	Sl. Decomp.	Sl. Decomp.	Rap. Decomp.	Rap. Decomp.
471°C (880°F)	Sl. Decomp.	Rap. Decomp.	Rap. Decomp.	Rap. Decomp.

The above information shows the importance of keeping the skin temperature below 440°C (824°F).

b. The furnace is equipped with a Juhn Zink-VBM-16 burner. Heat release:

Maximum: 3.240M BTU/Hr
Normal: 2.700M BTU/Hr

Heat release of the pilot:

Normal: 0.05M BTU/Hr

c. The pilot flame must be proven by the "purple peeper" before the main gas burner can be started.

2. Start-up Operations Prior to The Initial Batch

a. A three (3) day dryout cycle should be considered the minimum time required for drying the furnace refractory.

b. Block off valves in line from circulating pump and into still. Open vent in line from heater. Inject 100 psig steam into the coil. Pressure should be about 30 psig. This can be done by removing TJRI-128A, a 1½" connection. Put this thermocouple temporarily into a side furnace opening. A dial thermometer can be used instead of the thermocouple (opening T1 on Dwg. 91287-4-A1).

c. Open damper in furnace stack.

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d. Open manual valves in main gas line to the furnace and pilot line.

e. Gas test the atmosphere inside the heater. Use a 3 foot length of copper tubing on the end of a rubber hose. If test shows dangerous, stop and correct the condition before lighting the burner. When the heater is cold, there is no natural draft to carry away gas or fumes. After the unit is hot, a natural draft is always present.

f. It is now necessary to "jumper out" those connections in the circulating system which require a positive liquid flow through the coil.

g. Activate the main burner system and hold wall temperature to 204°C (400°F). Hold for 48 hours.

h. Increase firing rate and temperature to 371°C (700°F). Hold for 24 hours.

i. Firing rate can be increased to 482°C (900°F) during the fourth and subsequent days. Temperature recommendations are subject to a tolerance of plus, or minus, 38°C (100°F).

j. After the furnace is dry, leave the pilot light operating and remove "jumper" connections. Return furnace to original condition.

B. Other Features - Safety, Alarms, Interlocks

For these features, see Section VI - Distillation.

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Section VIII - Therminol System

A. Start-up Operations

1. Design Considerations (Refer to Dwg. 2080, D2)

   a. The existing heater has a design capacity of 6M BTU/hr of which only 2.8M BTU/hr is being utilized at present.

   b. A new surge tank, of 3,500 gallons working volume, is provided for the storage of hot Therminol.

   c. Flow rates from the surge tank will be:

		Design	Normal
Item 1-150	To Existing System	1,000 GPM	1,000 GPM
Item 1-158	To New System	350 GPM	300 GPM
Item 1-159	To Existing Furnace	450 GPM	400 GPM

   d. Estimated heat requirements:

New System	2M BTU/Hr
Existing System	3M BTU/Hr

   e. A heat balance across the system will show the following temperatures based on the heat requirements as listed above:

	Flow Rate lb/hr	Flow Rate GPM	Temperature	Loading
Into Furnace	232,000	400	275°C (527°F)	5.0M BTU/Hr
Out of Furnace	232,000	400	310°C (590°F)	
Into Existing System	583,000	1,000	275°C (527°F)	3.0M BTU/Hr
Out of Existing System	583,000	1,000	267°C (512°F)	
Into New System	175,000	300	275°C (527°F)	2.0M BTU/Hr
Out of New System	175,000	300	256°C (493°F)	

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2. Start-up Operations

a. Fill Therminol surge tank, Item 1-149, with 2,500 gallons of Therminol FR-2. Heat the material to 100-110°C with the steam coil. It may take 24-36 hours to do this since the coil was not designed for a large heat-up requirement.

b. Start Therminol into the suction of Pump 1-158. Be careful in opening valve, not to thermal shock the system.

c. Check that cooling water is on the stuffing box gland and pump bearings.

d. Align valves through new system and start pump. Check for leakages and flow.

e. Start Therminol into the suction of Pumps 1-150 and 1-159. Be sure discharge valves are closed.

f. Make proper tie-ins to the existing system and at the existing heater.

g. Put existing Therminol heater on low heat. Align valves and start Pump 1-159.

h. Align valves and start Pump 1-150.

i. Activate "Seal-Guard" system.

B. Routine Operation

1. The system in normal operation will require the periodic check of the pump systems to make certain they are operating correctly and not leaking.

2. The temperature controller in the existing heater will be adjusted to 310°C or to the desired operating temperature.

C. Safety Factors

1. A level gauge is located on the side of the surge tank, and the surge tank is vented to the atmosphere.

D. Control Loops, Interlocks, and Alarms

1. Control Loops

Control loops exist at the existing Therminol heater, and these are covered in the Department Operating Instructions.

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2. Interlocks

Interlocks exist at the existing heater and are covered in the Department Operating Instructions.

3. Alarms

When the Therminol pumps are shut down, an alarm will sound.

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