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I.G. FARBENINDUSTRIE A.G.

UERDINGEN

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COMBINED INTELLIGENCE OBJECTIVES  
SUB-COMMITTEE

RESTRICTED

I. G. FARBENINDUSTRIE A. G.

UERDINGEN, GERMANY

27-28 June 1945

Reported by:

Mr. W. HIRSCHKIND  
CWS, Hq. ETOUSA

1 August 1945

CIOS Target No. 22/1(N)  
Miscellaneous Chemicals

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE  
G-2 Division, SHAKF (Rear) APO 413

RESTRICTED

27p. diagrams

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I. G. FARBENINDUSTRIE A. G.

UERDINGEN, GERMANY

1. INTRODUCTION

This plant was visited on 27 and 28 June, 1945. The following information was obtained from Dr. Dilthey, the Assistant Director, and the staff enumerated below.

2. ORGANIZATION

The organization was essentially as follows:

- Inorganic Department: - Dr. Dilthey, Manager.
- Organic Department (1): - Dr. Meissner, Manager.
- Organic Department (2): - Dr. Frick, Manager (absent).  
- Dr. Dewein, Asst. Manager.
- Technical Department: - Mr. Mansfeld, Chief Engineer.
- Research Department: - Dr. Hamans, Director.

The plant was independent until about 1920, when it merged with I.G. It was founded by Dr. E. ter Meer, father of Dr. F. ter Meer, one of the present leading directors of I.G. Farben at Frankfurt, in about 1890 and controlled by him until about 1920 when the merger with I.G. took place. He continued as I.G. Director until his death. After the merger I.G. absorbed a chromate plant adjacent to it by the name of "R. Wedekind and Co." and combined it under the same management.

3. LIST OF PRODUCTS

<u>Product</u>	<u>Tonnage/Mo.</u>	<u>Product</u>	<u>Tonnage/Mo.</u>
Sulfuric acid		Benzoic acid	
Hydrochloric acid		Sodium benzoate	
Sodium bichromate	} 1000	Benzaldehyde	40
Sodium chromate		Benzyl chloride	150

Potassium bichromate )	1000	Dibenzyl ethers	
Chromic acid )		Benzyl alcohol tech.	50
Chromic oxide		and pure	
(Chrome Green) )	3000	Benzyl benzoate	20
Iron oxide, Colors:		Benzyl acetate	
Black		Cinnamic aldehyde	
Red		Diphenylmethane	
Yellow brown		Benzene, pure	
Zinc oxide (activated)	150	Toluene, pure	
Sodium arsenate		Nitrobenzene	800-1000
Wood impregnation agents		Glycerin acetate	
Basilite, Flux, etc.		Ethyl and methyl	
Aniline oil	800-1000	acetanilide	
Aniline salt		Polymerisat	
Ethyl aniline		Acetophenone	
Diethyl aniline		Plasticizers	
Ethylated toluidines		Elaol 1, 2 and 12	
Ethyl benzyl aniline		Softener K1	
Mono methyl aniline		Isododecylphenol	
Methyl diphenylamine		Softener NP and CX	
Diphenylamine tech.		Akydales (alkyd resins)	1000
Diphenylamine C.P.		Emulsifiers	
Phosgene		Cohesane	
Chlorocarbonic acid ester		Cosavultes, Covulsan,	
Diphenylurethane		Cosale	
Miscellaneous urethanes		Malachite green	20
Diphenyl urea		Brilliant green	40
Diethyldiphenyl urea		Fuchsin	25
(centralit 1)		Pararosanine	10
Dimethyldiphenyl urea			
(centralit 2)			
Miscellaneous ureas			
Acetanilide, dist.			
" pure (antifebrin)			
Aceto-toluid			

#### 4. RAW MATERIALS USED

Salt : from mine near Moers 20 km. Cost RM 1.05/ton.  
Coal : from own mine near Huch. Cost RM 18.50/ton.  
Water : pumped from Rhine.  
Sulfur dioxide: by custom roasting of pyrite and sphalerite.  
Sinters go to Duisburg Copper Smelter and to  
lithopone plants.  
Cost: RM .02-.03/kg.

Crude benzene  
Crude toluene  
Crude naphthalene

## 5. INORGANIC PRODUCTS

### a. Zinc Oxide for the Rubber Industry

#### (1) Raw Materials

Waste products containing zinc, such as brass, tin, dross, etc.

#### (2) Process

The raw materials were dissolved in hydrochloric acid and the solution allowed to settle. The supernatant liquor was decanted off and purified with zinc dust and sodium carbonate (iron). After filtration through presses the clear solution was treated with sodium carbonate and the precipitated basic zinc carbonate filtered and washed. It was subsequently calcined at temperatures of 3-400°C.

### b. Sodium Arsenite

Sodium arsenite was recovered from oxidation processes (at other I.G. plants) and was shipped to Uerdingen where it was reoxidized by roasting in hand and rotary furnaces at low temperatures, 100-200°C.

### c. Iron Oxide Pigments

#### (1) Raw Materials

Solution obtained in reduction of nitrobenzene with iron. Pickling solution from steel and galvanizing works.

#### (2) Process

The solutions were precipitated with the theoretical quantity of milk of lime. The precipitate was allowed to settle and the supernatant liquor decanted off. The sludge was filtered on a rotary filter, washed, dried and calcined in a kiln at a temperature selected according to the quantity and color of the desired product. The primary colors are: yellow, red, brown and black. Desired shades were obtained by blending.

#### (3) Uses

Paint and building industry. Sold for use in alkyd resins, solvents and lacquers. Before the war 50% of the total products were exported.

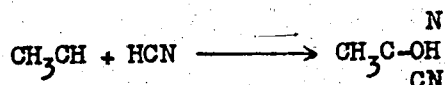
### d. Alkacid Process

For removal of H<sub>2</sub>S and CO<sub>2</sub> from gases (hydrogen, watergas, synthesis gas, air).

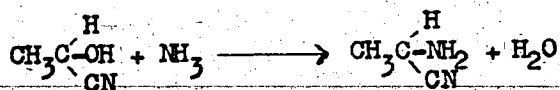
This process has been developed by I.G. Farben and is widely used in the industry of synthetic ammonia and hydrogenation (I.G. and Fischer-Tropsch method).

The absorbent is the sodium salt of alpha-propionic acid, which was manufactured and sold by I.G. Farben under the name of "Alkacid."

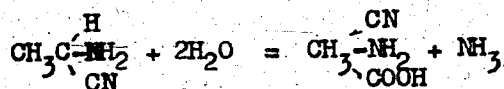
Method of Preparation: Acetaldehyde was treated with hydrocyanic acid which combines under formation of the cyanhydrin



The cyanhydrin was converted into aminonitrile by action of  $\text{NH}_3$



The nitrile was hydrolysed with HCl to the amino acid



Treatment with caustic soda yielded the sodium salt.

The sodium aminopropionate was used in 20% aqueous solution. It absorbs  $\text{CO}_2$  and  $\text{H}_2\text{S}$  at normal temperature and pressure approximately in the same quantities as a caustic soda solution of equal strength. Heating to  $100^\circ\text{C}$  will completely regenerate the solution.

Equipment: The absorption vessel was a cylindrical tank of approximately 6' diameter and 12' length. The built-in heating coils are made of K4.

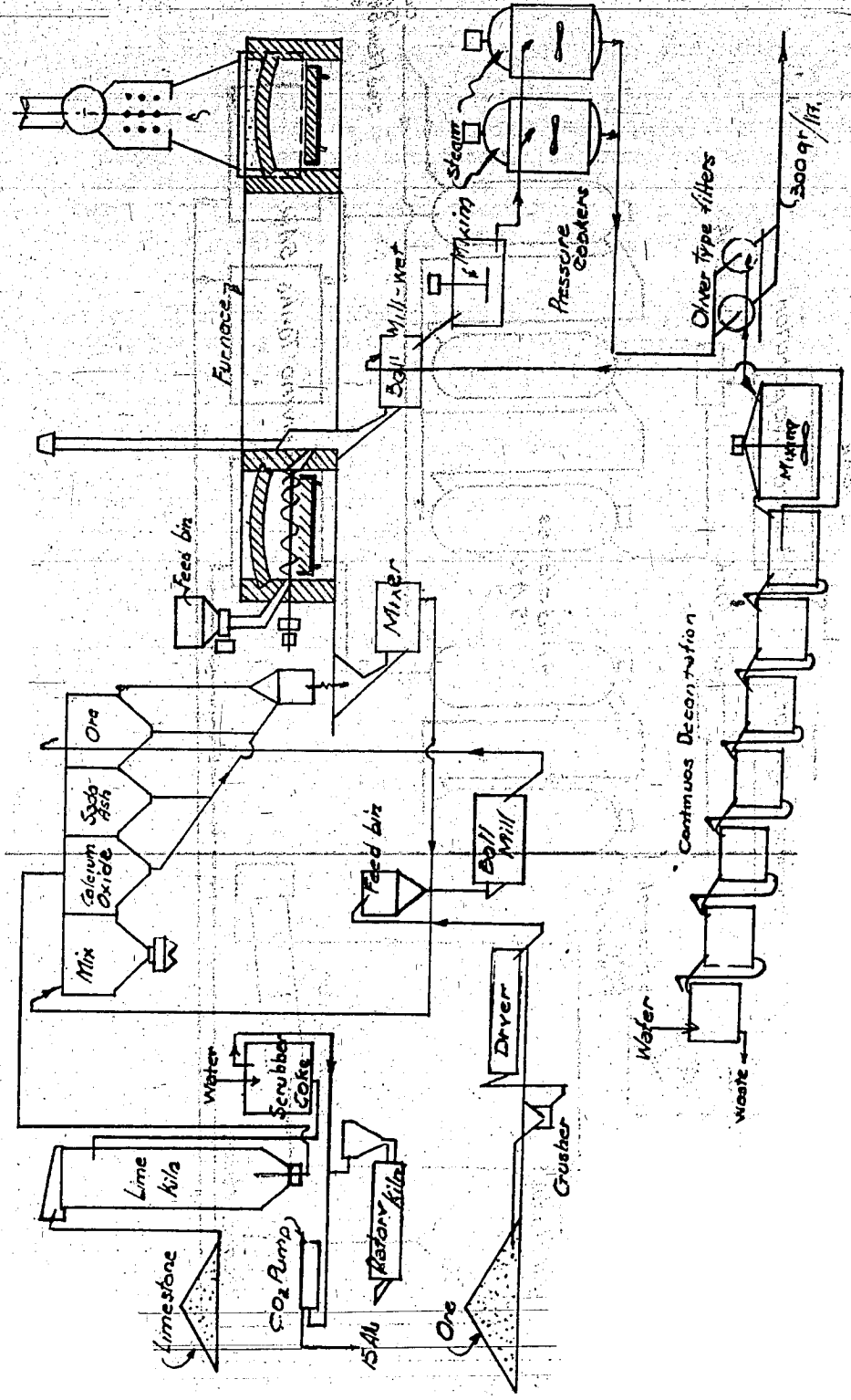
#### e. Basilite (Wood Preserving Agent)

Basilite is a highly effective mixture for wood preservation, composed of arsenates, chromates, fluorides and dinitrophenol. It is said to be superior to copper compounds.

#### f. Chrome Compounds

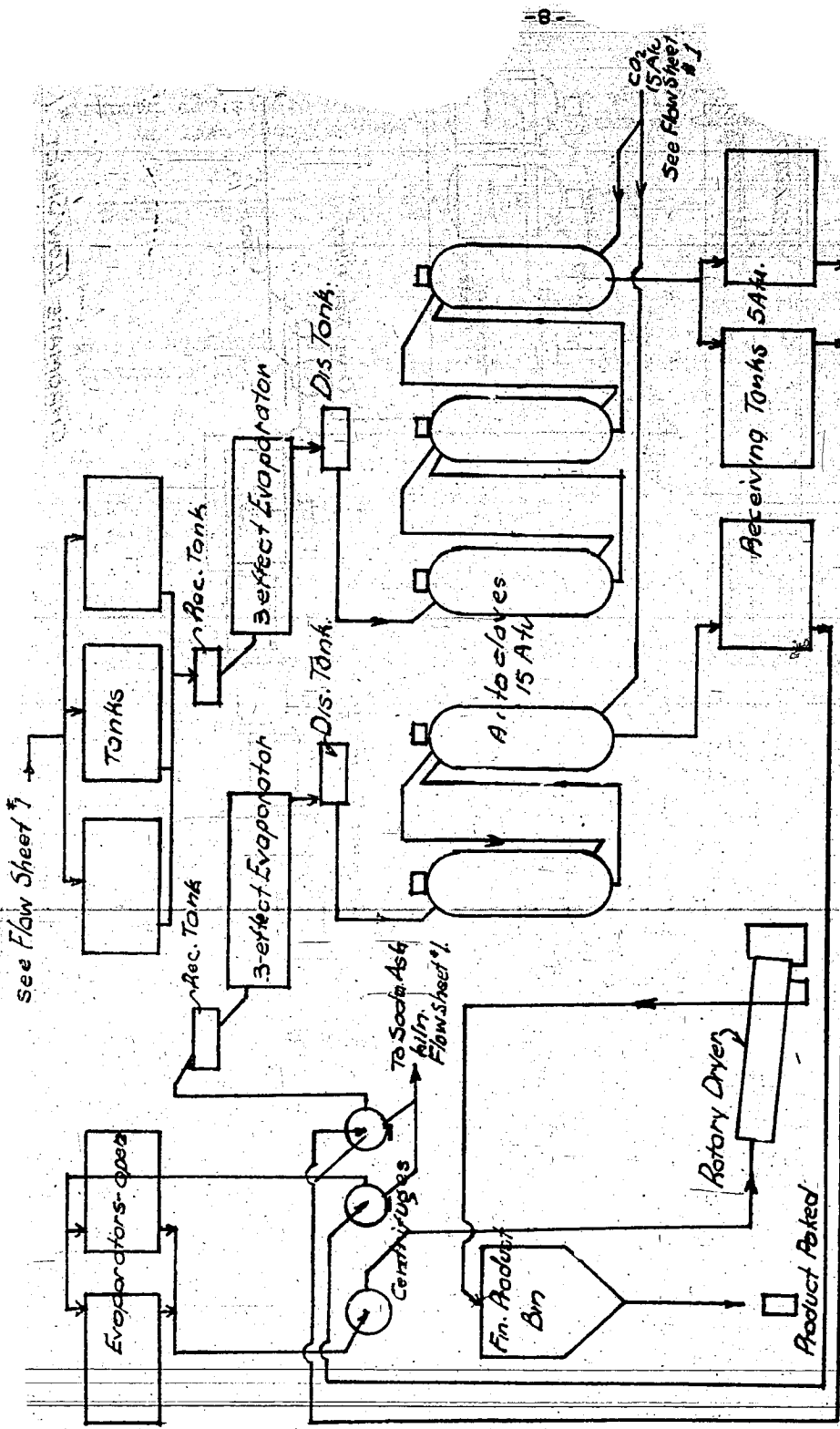
Chromates, Bichromates, Chromic Acid, Chromic Oxide (Chrome green).

The manufacture is dangerous. Some people lose, even on short exposure, the cartilage of their nose, while others are immune.



CHROMATE FLOW SHEET #1





Prolonged exposure was said to cause cancer of lungs. A rigid examination of individuals by X-ray in periodic intervals has been inaugurated. Painstaking precautions for dust prevention and exhaustion and condensation of all vapors carrying chromates have been installed.

The plant was built in 1935 at an approximate cost of RM 12,000,000. The plant was started with South African chrome ores containing 45% Cr<sub>2</sub>O<sub>3</sub>. During the war low grade ores from Jugoslavia containing 28-32% Cr<sub>2</sub>O<sub>3</sub> had to be used with a reduction in capacity of about 50%. High grade chrome ores yield an extraction of approximately 75-80% of contained chrome, while in low grade ores the extraction drops to 60%. In addition to this, low grade ores entailed a greatly increased consumption of chemicals.

### Description of Operations (see flow sheet)

#### (1) Burning of Lime

Two stack kilns, 25 m length, 2.5 m diameter, are installed, one of which was used as a spare. Capacity of kiln was 1000 tons limestone/month. The limestone coke mixture of approximately 8% coke was charged at the top and the burned lime was drawn intermittently from the bottom. The gases containing 35% CO<sub>2</sub> were scrubbed with water in a coke scrubber and compressed to 15 atm.

#### (2) Beneficiation of Chrome Ore

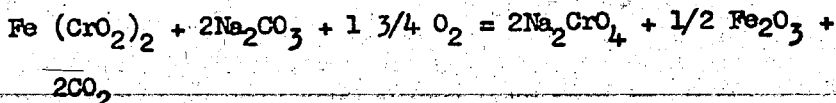
Chromite ore was crushed to approximately 10 cm size in a jaw crusher, dried in a rotary drier to remove mechanical moisture, and stored in a feed bin. From there it was fed to a ball mill with a capacity of 6 tons/hours, where it was ground dry to approximately 200 mesh. The ground material was stored in a large overhead bin of reinforced concrete. Overhead bins were also provided for soda ash lime and mixed feed. 35-40% lime was used in the mix while the ratio of soda ash to ore depended on the chrome content. Object of lime was to prevent fusion.

Ore, lime and soda ash were measured into a revolving drum where they were mixed and elevated to the bin. The mixed feed was then charged into the furnace through a hopper containing the feeder mechanism.

A gas fired annular furnace of 24 m outside and 18 m inside diameter contained a moving steel trough which is brick lined. A drive gives an adjustable speed of the trough of 2-6 minutes per revolution. A helix was provided to move the mixture to the inner circle and discharge, furnishing agitation and aeration at the same time. One pitch of the helix is equal to one revolution of the bed and a double pitch at the end discharged the material. The temperature in the calciner was 1050-1100°C. With high grade ores the

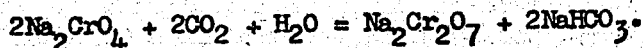
calclna dropped through an enclosed hopper into a wet ball mill where it was ground and leached to a concentration of 300 gpl sodium chromate (expressed as  $K_2Cr_2O_7$ ). The ball mill effluent went to an agitated tank thence to two pressure cookers used alternately, where a temperature of  $150^\circ C$  and 5 atm. pressure was maintained by introduction of live steam. The cookers are 10 cbm in size but filled only to 6 cbm. Its contents were discharged into 2 overhead receivers of 25 cbm capacity each from where they were fed to 2 rotary filters each of  $12 m^2$  surface. The sludge was repulped and washed counter-currently in 6 cascaded decanting tanks. The filtrate containing 300 gpl sodium chromate (expressed as  $K_2Cr_2O_7$ ) went to storage while the wash water of approximately 100 gpl sodium chromate was returned to the ball mill. The washed sludge was discarded.

The basic reaction of the chrome ore beneficiation is the following:



### (3) Evaporation and Crystallization of Sodium Bichromate

The sodium chromate liquor from storage was fed to horizontal triple effect evaporators where it was concentrated to 700 gpl. At this point it was continuously carbonated with 50%  $CO_2$  gas derived from a mixture of lime kiln gas containing 35%  $CO_2$  with bicarbonate calciner gas containing 90%  $CO_2$ . The carbonation was carried out at 15 atm (pressure of  $CO_2$  compressors) in 3 agitated autoclaves with liquor and gas running counter currently. The purpose of the carbonation is the conversion of the sodium chromate to sodium bichromate according to the equation:



The effluent from the carbonators was passed into horizontal receivers where the pressure was released to 5 atm. and from there to a centrifuge where the sodium bicarbonate was separated from the bichromate liquor. The latter went to a receiver and thence to a second set of triple effect evaporators where it was concentrated to 1100 gpl bichromate (expressed as  $K_2Cr_2O_7$ ).

The bicarbonate of soda was discharged from the centrifuge basket and conveyed through a bin to a calciner where it was converted into soda ash under recovery of 90%  $CO_2$  gas which was drawn off continuously, mixed with the lime kiln gas and compressed to 15 atm.

The liquor from the second evaporating step containing 1100 gpl bichromate went to the second carbonation carried out in 2 agitated autoclaves in series, liquor and gas flowing as in No. 1

countercurrently. The effluent from carbon step No. 2 was again expanded to 5 atm. in a receiver from where it was fed to a centrifuge for separation of bicarbonate of soda from the bichromate liquor. The bicarbonate went to the calciner while the bichromate liquor was pumped to a third evaporation step in open steam heated kettles where the final concentration to 1600 gpl bichromate took place. The liquor was cooled and crystallized under agitation, thence centrifuged. The bichromate crystals were subsequently dried in a rotary drier, elevated to a storage bin, out of which they were weighed and packed into steel drums. The mother liquor from the centrifuge was returned to the second evaporation.

#### (4) Manufacture of Sodium Chromate

A part of the liquor from the first evaporation step (before carbonation) was bled out and evaporated from 700 gpl to approximately 900 gpl in open tanks equipped with steam coils and agitators. After the concentration was reached the liquor was cooled under agitation and the resulting crystal slurry centrifuged. ~~The crystals went directly to a bin for packing and shipping. The mother liquor was returned to the evaporator.~~

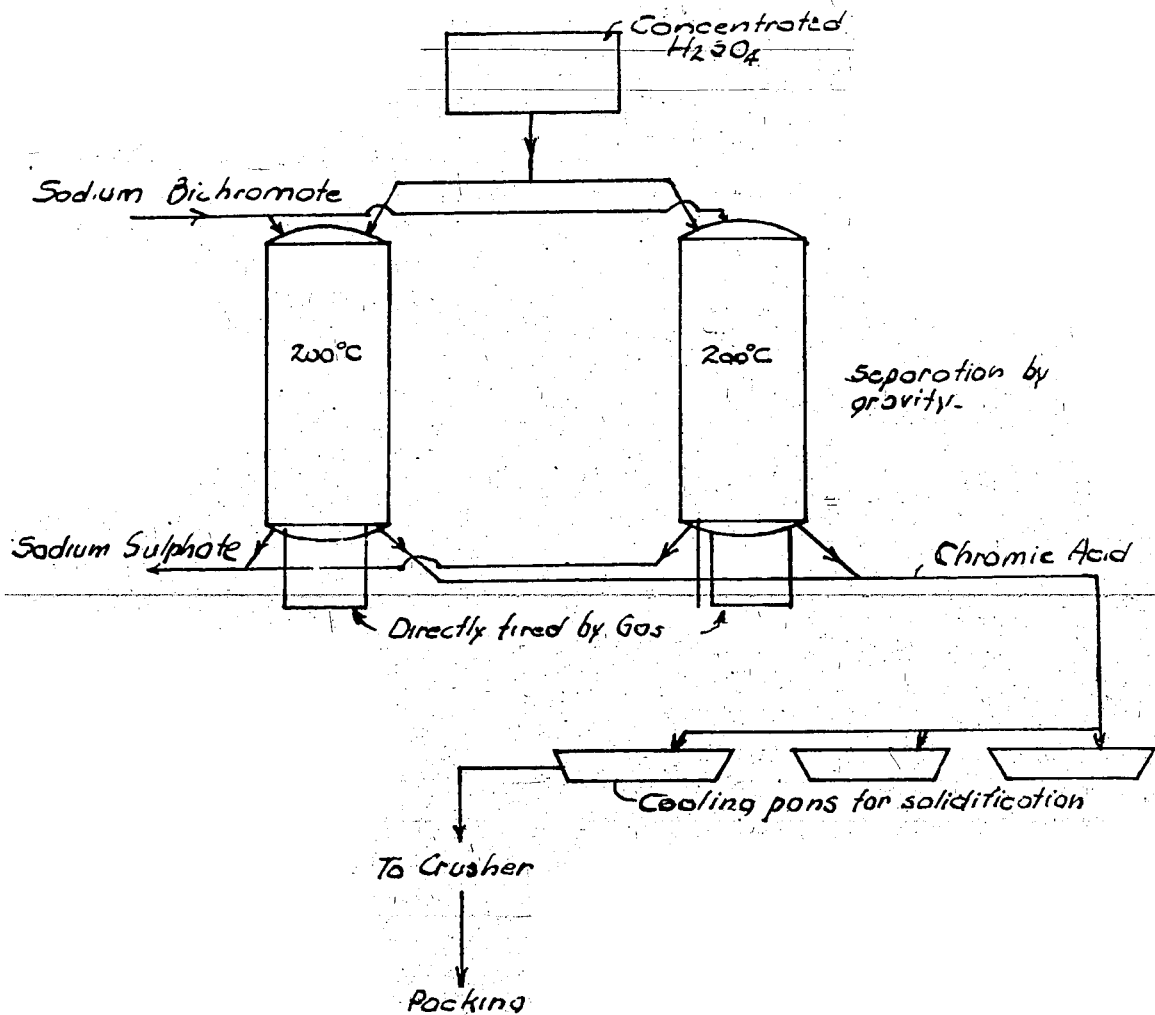
#### (5) Manufacture of Potassium Bichromate

Sodium bichromate liquor from the second evaporation step containing 1100 gpl went to storage tanks and from there to a feed and measuring tank from which a measured amount was pumped to an agitated tank equipped with steam coils. After heating to boiling an equivalent amount of solid potassium chloride was added whereupon the conversion to potassium bichromate took place with separation of salt. The resulting slurry was filtered through a Buechner funnel with suction applied from a steel "Monntejus." The hot filtrate was then passed into three agitated tanks equipped with cooling coils where potassium bichromate crystallized out on cooling. The slurry went to a centrifuge with a bronze basket where the crystals were separated, conveyed to a bin and packed. The mother liquor was transferred into the open heaters for reconcentration, during which additional salt is separated. This was filtered on the Buechner funnel and the liquor returned to the conversion cycle.

#### (6) Manufacture of Chromic Acid

Sodium bichromate crystals were heated with concentrated sulfuric acid to 200°C in two steel cylinders directly fired by gas. The molten mass separates into two layers, the upper being chromic acid and the lower sodium bisulfate. After drawing off the bisulfate layer, the molten chromic acid was emptied into iron pans where it solidified and was crushed and packed.

Size of batch approximately 300 lbs.



FLOW-SHEET FOR CHROMIC ACID  
Batch Process

(7) Manufacture of Chrome Green (Cr<sub>2</sub>O<sub>3</sub>)

Chromic oxide from oxidation of organic substances by means of chromic acid or bichromate was converted into pigments of various colors. The crude product was suspended in water in 2 agitated tanks from where it was dried on a rotary drum gas fired inside. The dry granular product from the drum went to a master furnace with revolving hearth, gas fired, to be calcined at 800-1000°C. The calcine was suspended in water and the slurry filtered and washed on a rotary filter. It was then dried in a tunnel drier with a traveling belt of steel screen and stored in a bin. Subsequently it was ground to 300 mesh in a Raymond type mill with air separator and passed to mixers for blending and to bins for packing.

6. ORGANIC PRODUCTS

Dr. Dewein, Assistant Works Manager.

a. Carbon Monoxide, Phosgene, Chlorocarbonic Ester

Raw materials: coke and chlorine.

Coke was heated to the combustion point. Pure oxygen from the Linde plant was then passed over it in brick lined steel equipment. The reaction is strongly exothermic and creates a temperature of approximately 2000°C. The CO gas was washed with water and stored in a gas holder. The almost pure CO from the gas holder was dried over concentrated sulfuric acid, mixed with chlorine and passed over activated charcoal as catalyst at temperature of 50 - 60°C at atmospheric pressure. The temperature is maintained by steam heat. The resultant phosgene is liquefied by cooling and stored in steel tanks.

Equipment: Reaction - lead lined steel. Other equipment: steel.

Phosgene and ethyl alcohol react under cooling to form chlorocarbonic ester  $\text{COCl}_2 + \text{HOC}_2\text{H}_5 = \text{HCl} + \text{COCLOC}_2\text{H}_5$ .

b. Benzene, Toluene, Nitrobenzene, Aniline Oil

Pure benzene and toluene were prepared from their crudes by distillation. Nitrobenzene were produced by the standard method from benzene and mixed acid. Reduction of nitrobenzene with iron furnished aniline oil, while the iron solutions formed were utilized for manufacture of iron pigments.

c. Substituted Anilines, Phenylamines, Urethanes and Ureas

(1) Ethyl Aniline

Aniline and ethyl alcohol were reacted using phosphorus

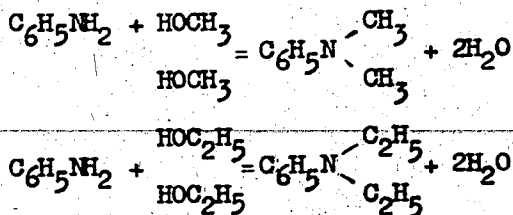
trichloride as catalyst. The primary product consists of: aniline, monoethylaniline, diethylaniline.

Distillation:

1st cut - aniline monoethylaniline - 1 column.  
Main fraction: mono and diethylaniline - 2 column.  
Batch distillation: diethylaniline.

(2) Dimethylaniline and Diethylaniline

These products were prepared by heating of aniline with alcohol and hydrochloric acid -



Preparation

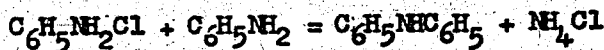
(a) Old method - aniline was heated with alcohol and aqueous HCl to 180°C in an enamelled autoclave at 20 atm. pressure.

(b) New method - aniline was heated with alcohol and aqueous HCl to 280°C in a steel autoclave at 100 atm. pressure in presence of PCl<sub>3</sub> as catalyst.

Direct heating was used in both methods, either using coal or gas as a fuel.

(3) Diphenylamine, Techn. Pure

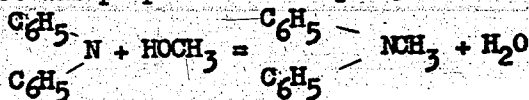
Aniline oil and aniline salt were heated in autoclaves to 200-230°C -



The pure product was prepared by recrystallization from ethyl alcohol.

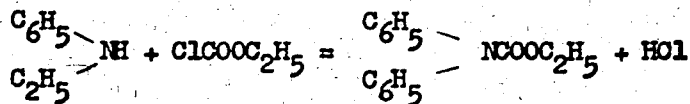
(4) Methyldiphenylamine

This product was prepared from diphenylamine, methanol and 30% aqueous HCl -



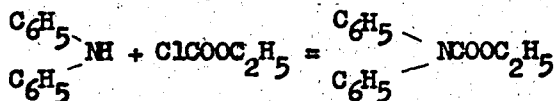
(5) Ethylphenyl Urethane

Monoethylaniline was reacted with chlorocarbonic ester -



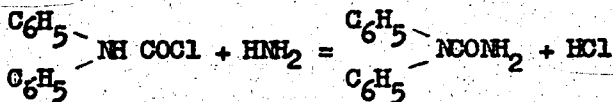
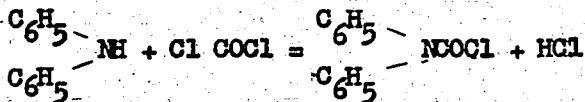
(6) Diphenyl Urethane

Diphenylamine was reacted with chlorocarbonic ester -



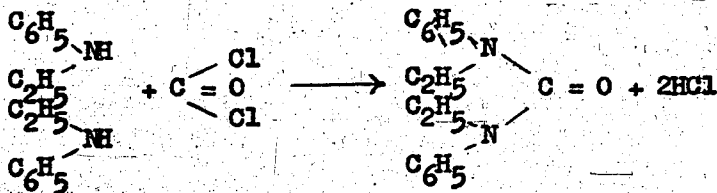
(7) Diphenyl Urea

By reaction of diphenylamine with phosgene and ammonia



(8) Diethyl Diphenyl Urea (Centralite 1)

Prepared by reaction of monoethylaniline with phosgene -



In presence of caustic soda at 40-60°C the reaction took place immediately.

Equipment: Agitated iron kettle.

(9) Dimethyldiphenyl Urea (Centralit 2)

Same as centralit (1) using monomethyl aniline instead of monoethylaniline. An important use for above mentioned substituted urethanes and ureas was the stabilization of explosives.



(10) Acetanilide

Aniline was reacted with glacial acetic acid. The crude product was purified by recrystallization from water, used activated charcoal for decolorizing.

(11) Acettoluide

Same as above except ortho toluidine was used instead of aniline.

(12) Ethyl and Methyl Acetanilide

Monomethyl aniline and monoethylaniline were reacted with glacial acetic acid.

The products were used as plasticizers.

d. Chlorination of Toluene and Derivatives

(1) Benzyl chloride, benzalchloride and benzotrichloride

The chlorination of toluene was carried out in lead lined agitated kettles above  $100^{\circ}\text{C}$ . The combined yields of benzyl and benzalchloride were over 80%. The products were purified by distillation.

Process and Equipment: -  $\text{PCl}_5$  was used as catalyst. The equipment consists of 5 lead lined kettles<sup>5</sup> equipped with tubular condensers and pipe cooler. The valves and fittings are of lead or ceramic ware. Chemical lead must be used for all equipment. Three of the five kettles are of 8 cbm, 2 of 1 cbm size. The rate of chlorination for the large kettle was as follows:

5 tons benzyl chloride required 24 hours.  
5 tons benzalchloride required 72 hours.  
5 tons benzotrichloride required 80 hours.

The end point of the chlorination was determined by temperature and gravity.

Benzyl chloride  $8^{\circ}\text{Be}$  -  $120^{\circ}\text{C}$   
Benzalchloride  $33^{\circ}\text{Be}$  -  $135^{\circ}\text{C}$   
Benzotrichloride  $38^{\circ}\text{Be}$  -  $135-150^{\circ}\text{C}$

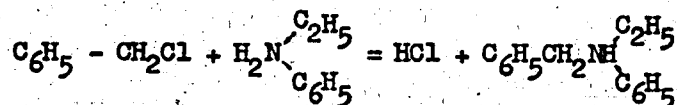
The two main products, benzyl and benzachloride, were separated and purified by batch distillation in lead lined column under vacuum.

1st part: benzyl chloride - atmospheric pressure to 200 mm pressure.

1st part: benzalchloride - 200 mm pressure to 35 mm pressure.

(2) Ethyl and Methyl Benzyl Aniline

The products were prepared from benzyl chloride and mono-ethyl and monomethylaniline respectively -



(3) Benzyl alcohol was prepared by 2 methods:

(a) Benzyl chloride was heated with ground limestone in aqueous phase at a temperature of 120°C in a brick lined kettle under pressure. The benzyl alcohol contains 10% dibenzyl ether.

(b) Benzyl chloride was heated with 30% caustic soda solution at a temperature of 120°C in an iron kettle under pressure. The product contained 30-50% dibenzylether. The reaction products, benzyl alcohol and dibenzyl ether, were distilled or double distilled in iron columns under vacuum.

(4) Benzyl acetate

Benzyl chloride and anhydrous sodium acetate were reacted at a temperature of 150°C under pressure using pyridine as catalyst. The product was purified by distillation in aluminum stills. Pyridine was removed by treatment with sulphuric acid.

(5) Benzaldehyde

Benzal chloride was treated with 60% Be sulphuric acid in a lead lined agitated kettle at 60-70°C. The aqueous layer (containing H<sub>2</sub>SO<sub>4</sub>) was separated from the oil and recycled. The oily layer was treated with soda ash solution in iron vessels to 120°C at a pressure of 3 atm. Subsequently, the benzaldehyde was distilled over by steam distillation. The remaining soda ash solution was acidified with aqueous HC to precipitate benzoic acid, which was recovered.

(6) Benzylbenzoate

(a) Benzaldehyde was converted to benzylbenzoate simply by adding benzyl-aluminate as catalyst. The reaction is exothermal causing a temperature rise of 19°C. The catalyst was prepared from benzyl alcohol by treatment with metallic aluminum.

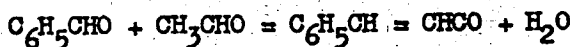
The crude benzylbenzoate was purified by vacuum distillation, single or double copper stills.

(b) Benzyl benzoate was also produced by reaction of benzyl alcohol with benzoic acid of a temperature of 120-150°C. The crude material is purified as described above.

The production of benzylbenzoate was 20 tons per month, 10 tons by each process.

(7) Cinnamic Aldehyde

This product was prepared by condensation of benzaldehyde and acetaldehyde with mercuric chloride as catalyst -



(8) Cinnamic Acid

This compound was prepared from the aldehyde by oxidation with air.

(9) Acetophenone

Ethyl benzene was oxidized with air in presence of a catalyst consisting of cobalt and manganese salts of organic acids such as naphthenic or synthetic fatty acids. The reaction was carried out in towers either as a batch process in a single tower or as a continuous process in a series of towers. The towers may be built of iron (surface treated with  $H_3PO_6$ ) of aluminum, or may be brick lined.

The products from batch and continuous process differ in composition.

(a) Product from batch process -	
Acetophenone + phenyl methyl carbinol	60%
Benzoic acid + resins	15%
Unreacted ethylbenzene	Balance
(b) Product from continuous process -	
Acetophenone	80%
Phenyl methyl carbinol	5%
Benzoic acid	5%
Resins	5%

The product from the continuous process was treated with bichromate and sulphuric acid, washed, dried with calcium chloride and distilled in vacuum in iron columns.

The product from the batch process was first distilled for the removal of unconverted ethylbenzene after which it was treated as above.

(10) Sodium Benzoate

This compound was produced by the process of Bozel-Malettra (Germar patents 537, 982). Toluene was oxidized with an aqueous solution of sodium bichromate (400 gpl) at a temperature of 280-300°C in autoclaves at 200 atm. pressure. The material proportions are as follows:

Sodium bichromate	- 3 pts.
Water	- 6 pts.
Toluene	- 9 pts.

The chromic oxide was separated by filtration and the sodium benzoate recovered from the solution by crystallization. It was purified by recrystallization from water.

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e. Miscellaneous Organic Compounds

(1) Mono, Di and Triacetate of Glycerine

Glacial acetic acid and acetic anhydride were reacted with glycerine in different proportions. The products are used as plasticizers.

(2) Cohesane, Cosavulte, Cosale

These are solutions of nitrocellulose in ethylacetate in varying proportions and were used as glues for leather, paper, textiles, wood, etc.

(3) Elaol 1, 2 and 12

These are plasticizers which were prepared from fatty acids and hexanetriol by esterification. Elaol 1 used fatty acid C<sub>5</sub>, C<sub>6</sub> and C<sub>7</sub>. Elaol 2 used higher fatty acids. Elaol 12 was a mixture of 1 and 2.

(4) Plasticizers NP, CX and KI were prepared from xyleneol and phosgene.

(5) Alkydale (alkyd resins)

These compounds were prepared from phthalic anhydride, glycerine and fatty acids from either linseed or castor oils. They have a very viscous sticky consistency and a faint oily smell.

Alkydale from linseed oil fatty acids: -

- (a) L - made with 60% fatty acid air dried (like linseed oil paint)
- (b) T - made with 50% fatty acid air dried (harder than L)
- (c) TT - made with 40% fatty acid oven dried at 110°C (harder than T)

Alkydale from castor oil fatty acid:

- (d) ST - made with 60-63% fatty acid; used with nitro-cellulose lacquers, chiefly for automobile finishes.
- (e) Membranit - water emulsified resin paint, used outside and inside on two tone papers.

Glycerine substitute for use in "alkydale."

(6) Adamsite

(Information from Dr. Hamans, Research Director).

Diphenylamine and arsenic trichloride were heated together in a lead lined kettle equipped with agitator. Content of kettle is 3-5 cbm. The raw materials were mixed, heated until all HCl is liberated and driven off. The fused product (MP 220°C) was drawn off into iron vessels where it was allowed to solidify. It was ground to 2-300 mesh in a disintegrator and packaged in iron drums holding 100-120 kg. These drums were placed into plywood containers and shipped.

(7) Phthalic Acid Anhydride

The process by which this compound was to be manufactured was the well known catalytic oxidation of naphthalene with air using vanadium pentoxide as catalyst. Water and air cooled chambers were to be used for collection of phthalic anhydride from the converter gases. The product was to be purified by distillation followed by flaking on a water cooled drum.

This plant was under construction; buildings are completed and of the received equipment some was installed and some stored in the yard.

Total cost of Plant: buildings, equipment, electrical substations, etc., 4.5 - 5,000,000 RM.

~~Capacity: 300-400 tons/month.~~

Since none of the personnel available were acquainted with operational features, only design information was obtained. The process was similar to normal practice except for the following (see flow sketch attached):

(a) Process air flow was introduced ahead of converter and exhausted at end of train by additional blowers.

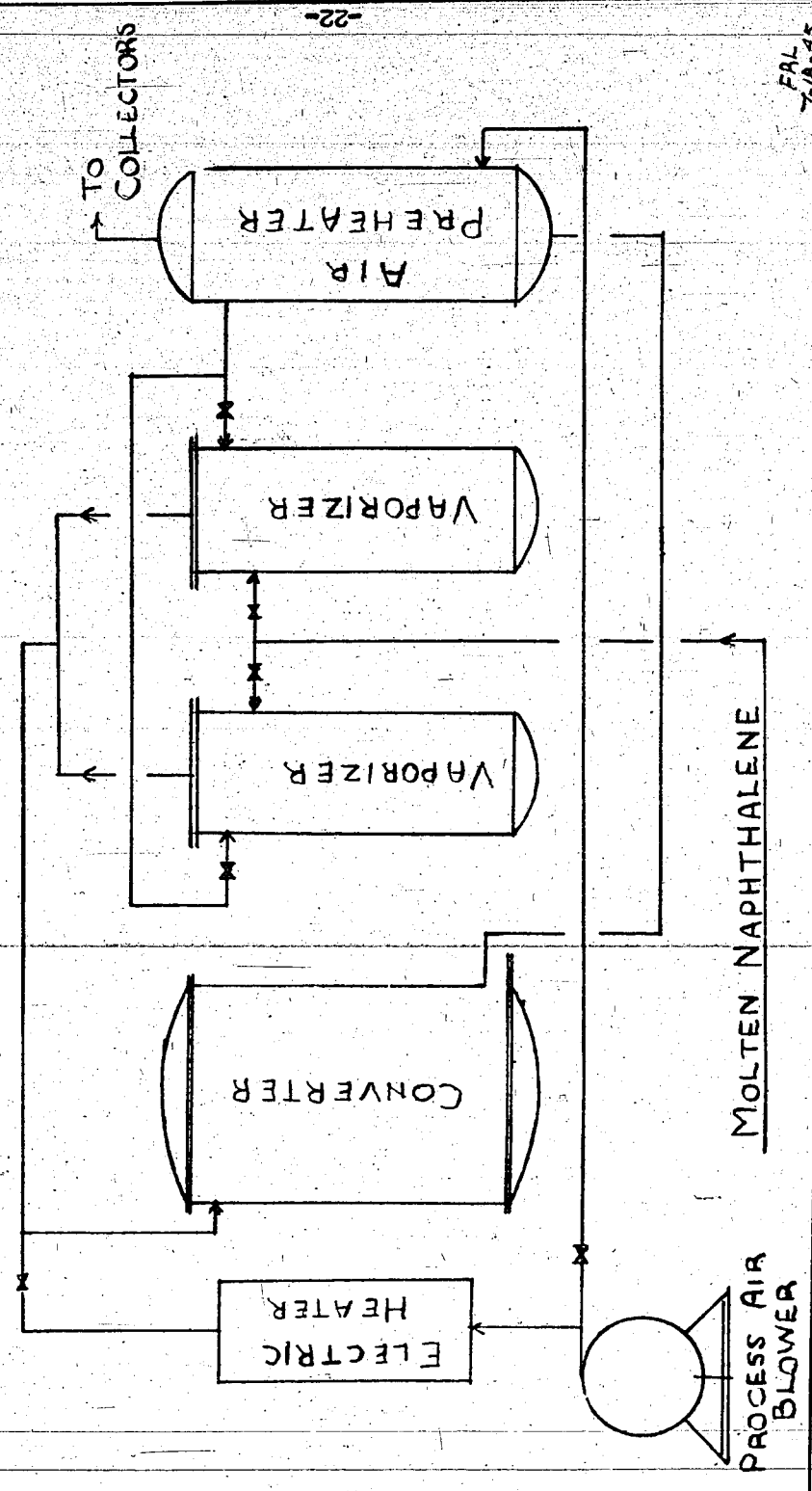
(b) Semi-continuous (cyclic) water and air cooled collecting chambers were employed.

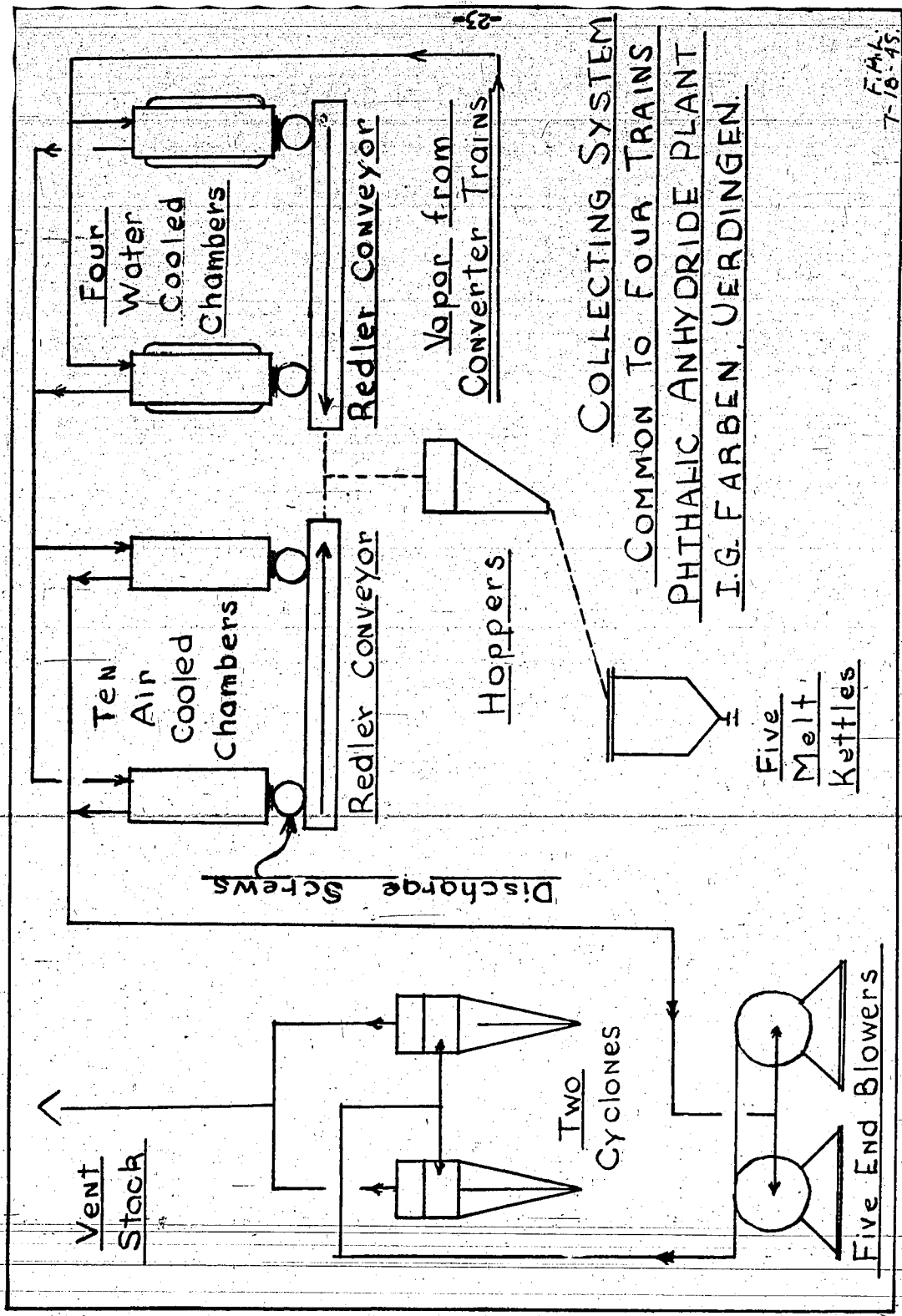
(c) Distillation kettles were heated by individual high pressure (120-150 atm) hot water systems.

(d) Converters and vaporizers differ from conventional designs.

(e) Feed rates are lower, being 0.63 mol % naphthalene in air.

CONVERTER TRAIN  
PHTHALIC ANHYDRIDE PLANT  
I.G. FARBEN, UERDINGEN

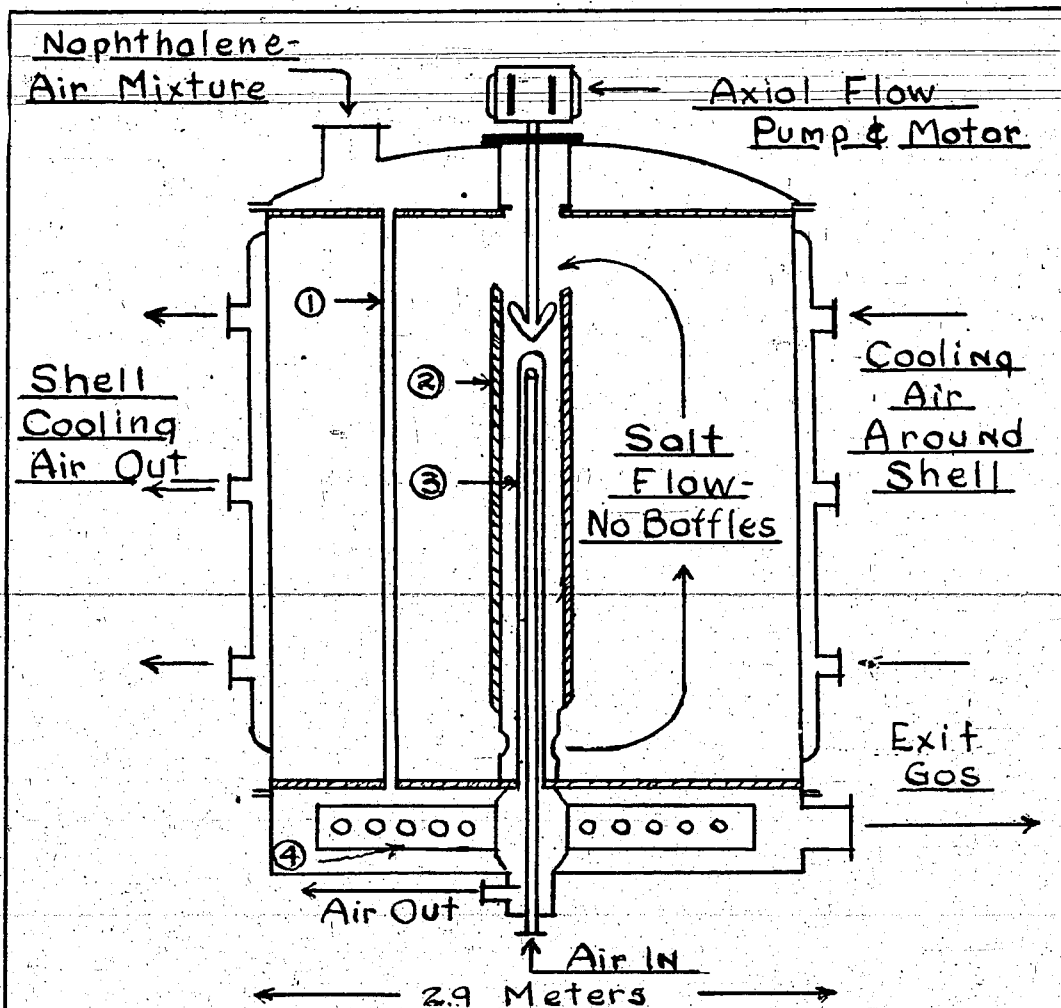




COLLECTING SYSTEM  
COMMON TO FOUR TRAINS  
PHTHALIC ANHYDRIDE PLANT  
I.G. FARBEN, UERDINGEN.

F.H.A.  
 7-18-45

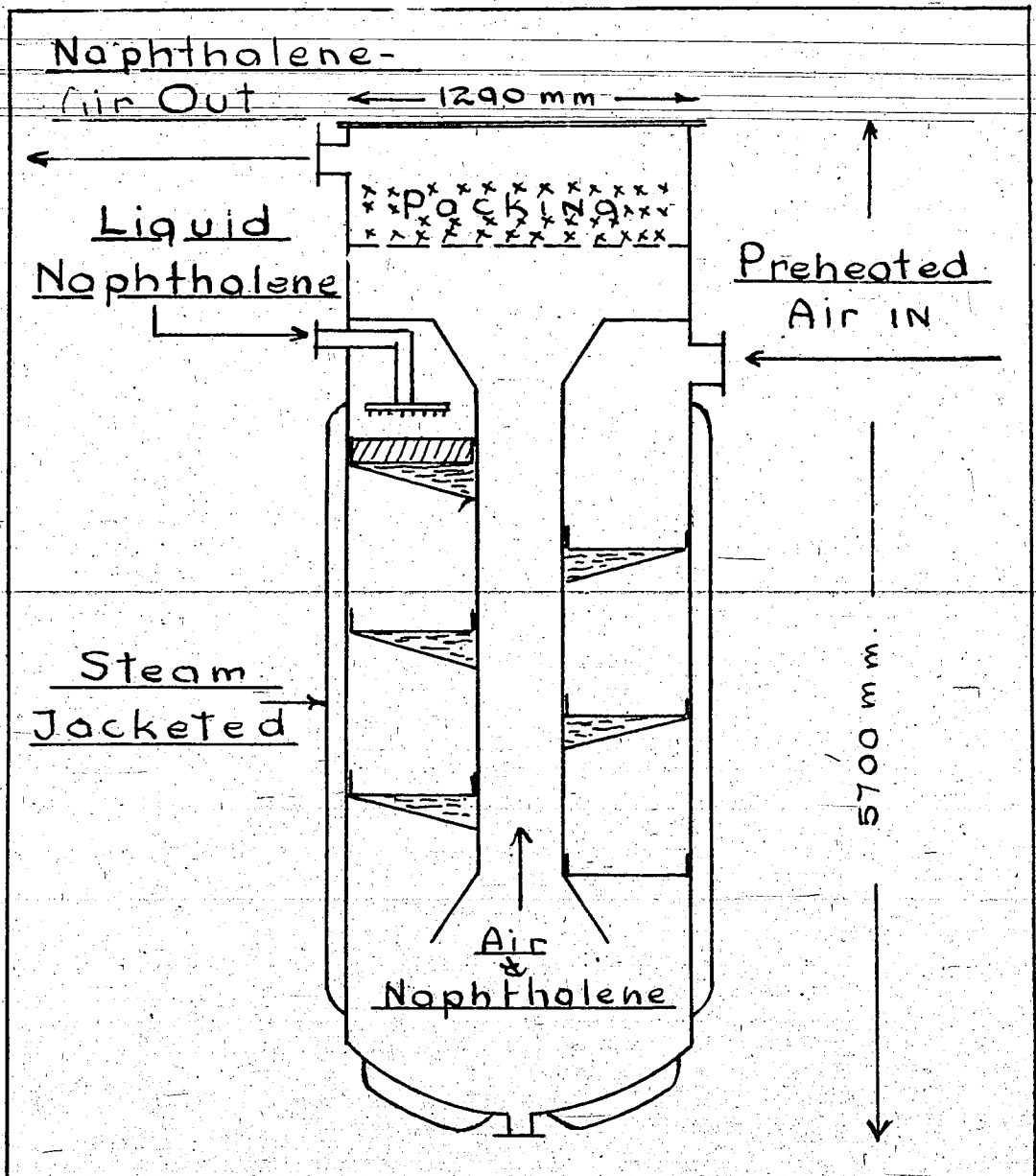




- ① 2946 Catalyst Tubes - 30.2 mm. I.D. x 3289 mm.
- ② Draft Tube
- ③ 37 Boyonet Salt Cooling Tubes, 57.2 mm. I.D. x 2500 mm.
- ④ Gos Distributor & Pressure Equalizer

CONVERTER  
PHTHALIC ANHYDRIDE PLANT  
I.G. FARBEN. UERDINGEN

F.R.L.  
7-18-45



NAPHTHALENE VAPORIZER  
PHTHALIC ANHYDRIDE PLANT  
I.G. FARBEN VERDINGEN

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