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URANIUM PRODUCTION — PROCESS DESIGNS FOR LEACHED ZONE PLANTS

Volume III. Alumina Recovery Section

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September 25, 1953

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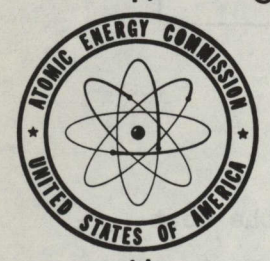

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URANIUM PRODUCTION
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I. INTRODUCTION

This volume is the third in a series of reports on processing Florida leached zone material for the recovery of uranium, alumina and phosphatic values.

Liquor from the proposed leaching operation is processed to crystallize ammonium alum which is treated with aqueous ammonia to precipitate an alumina hydrate. The alumina hydrate is dried and calcined to produce metallurgical grade alumina.

Basic design, plant capitalization and operating costs for the unit processes pertaining to the recovery of alumina are presented in this report. Data are presented for plants designed to produce 450, 225, and 100 tons of uranium per year.

Also included are estimates of capital and operating costs for a process which produces an impure alumina product suitable for feed to the Bayer process. In this process, alum is crystallized from the leached zone extract, washed, dehydrated and calcined to produce alumina. The estimates are for a plant producing 450 tons of uranium per year.

International Minerals and Chemical Corporation desires to acknowledge assistance received from Catalytic Construction Company in the preparation of this report.

II. SUMMARY

Process designs and cost estimates for two alternate processes in which alumina is recovered from leached zone are presented in this report.

In the first process, metallurgical grade alumina is produced from alum that has been purified by two crystallizations. Detailed design and cost estimates are presented for plants that have the following annual production:

Tons U/Year	450	225	100
Tons Al_2O_3/Year	393,120	196,560	87,360

Although a very pure alumina is produced in this process, capital costs and operating costs are relatively high. Efforts are being made to redesign the process to include equipment that would be less expensive and would still give a metallurgical grade alumina. Efforts are also being made to develop process changes in the design, in order to reduce operating costs. It is believed that additional laboratory and pilot plant work will bring about a considerable reduction in both capital and operating costs.

Following is a discussion of the steps in the first alumina recovery process. The alumina recovery operation takes place after the four-stage countercurrent filtration operation described in Volume II of this series (RMO 2013). Alumina is removed at this point for the following reasons:

1. Uranium extraction is simplified due to a less viscous slurry and absence of interferring metallic (Al) ions.

2. Alumina can be removed easily from the slurry by precipitation of ammonium alum.

3. No uranium has been found to be removed with the alum crystals by this process.

In this step of the process, the acid filtrate from the leaching section is concentrated to approximately 30% dissolved solids. Ammonium sulfate is added to combine with the aluminum sulfate present to form ammonium alum. Upon cooling, ammonia alum is crystallized and removed by filtration. The filtrate bearing the uranium and phosphate values is pumped to the Uranium Recovery Section (RMO 2015) for further processing. The ammonium alum crystals are recrystallized twice to obtain the purity desired.

Purified ammonium alum is reacted with excess aqueous ammonia to produce an alumina hydrate that will filter easily. The theoretical reaction taking place is as follows:

$$Al_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O + 6NH_4OH \text{ ----------}$$

$$Al_2O_3 \cdot xH_2O + 4(NH_4)_2 SO_4$$

Ammonium sulfate and ammonia are leached from the alumina hydrate with water in a countercurrent filtration operation.

Free ammonia is recovered, and the remaining ammonium sulfate is concentrated by evaporation, crystallized, and returned to the original alum precipitation operation in the forepart of the process. Excess ammonium sulfate is centrifuged and the cake sent to the ammonium sulfate decomposition process for recovery of ammonia and sulfur values.

The alumina hydrate cake is dried and calcined at a final temperature of 2190° F. to yield metallurgical grade alumina with the following analyses:

Chemical Analysis of Al_2O_3 Product

Na_2O	Trace
Fe_2O_3	0.017%
SiO_2	0.021%

Chemical Analysis of Al_2O_3 Product--Continued

P_2O_5	0.0015%
TiO_2	0.005%
CaO	0.01%
H_2O Sorption	1.0%

Screen Analysis of Al_2O_3 Product

-48 + 60	11%
-60 + 100	33%
-100 +200	51%
-200 + 325	5%

Summaries of the estimated capital cost and operating cost for the three plant sizes of the first process are as follows:

Summary of Estimated Capital Cost for Alumina Recovery

Plant Size	Capital Cost
100 Tons U/Year	$21,171,000
225 Tons U/Year	$37,689,000
450 Tons U/Year	$66,578,000

Summary of Estimated Operating Cost for Alumina Recovery

Plant Size	Dollars/Hour
100 Tons U/Year	$1,245.09
225 Tons U/Year	$2,261.28
450 Tons U/Year	$4,025.73

These cost estimates are based on presently available data, prices, experience and judgment.

Operating cost estimates include reagents, power, steam, fuel oil, water, direct labor, immediate supervision, maintenance and amortization based on a 15 year life for equipment and a 20 year life for buildings. Also included are insurance, local taxes and analytical expenses. Cost of feed solution, overhead, management, general plant facilities, interest and return on investment have not been included, but these items will be included in the summary report.

Ammonia used in this section of the process is obtained from the following sources:

1. Make-up Ammonia

2. Recycle from Ammonia Sulfate Decomposition Section.

3. Recycle from with in the Alumina Section.

Make-up ammonia is produced in the New Orleans area and is charged at $45.99, $49.84, and $58.34 per ton (delivered) for the 450, 225 and 100 ton plants, respectively. Recycle ammonia from the Decomposition Section is charged at $18.09, $19.25, and $21.68 per ton for the 450, 225, and 100 ton plants, respectively. No charge is made for the ammonia recycled within the Alumina Section.

Following is a simplified flow sheet of the Alumina Section for the first process.

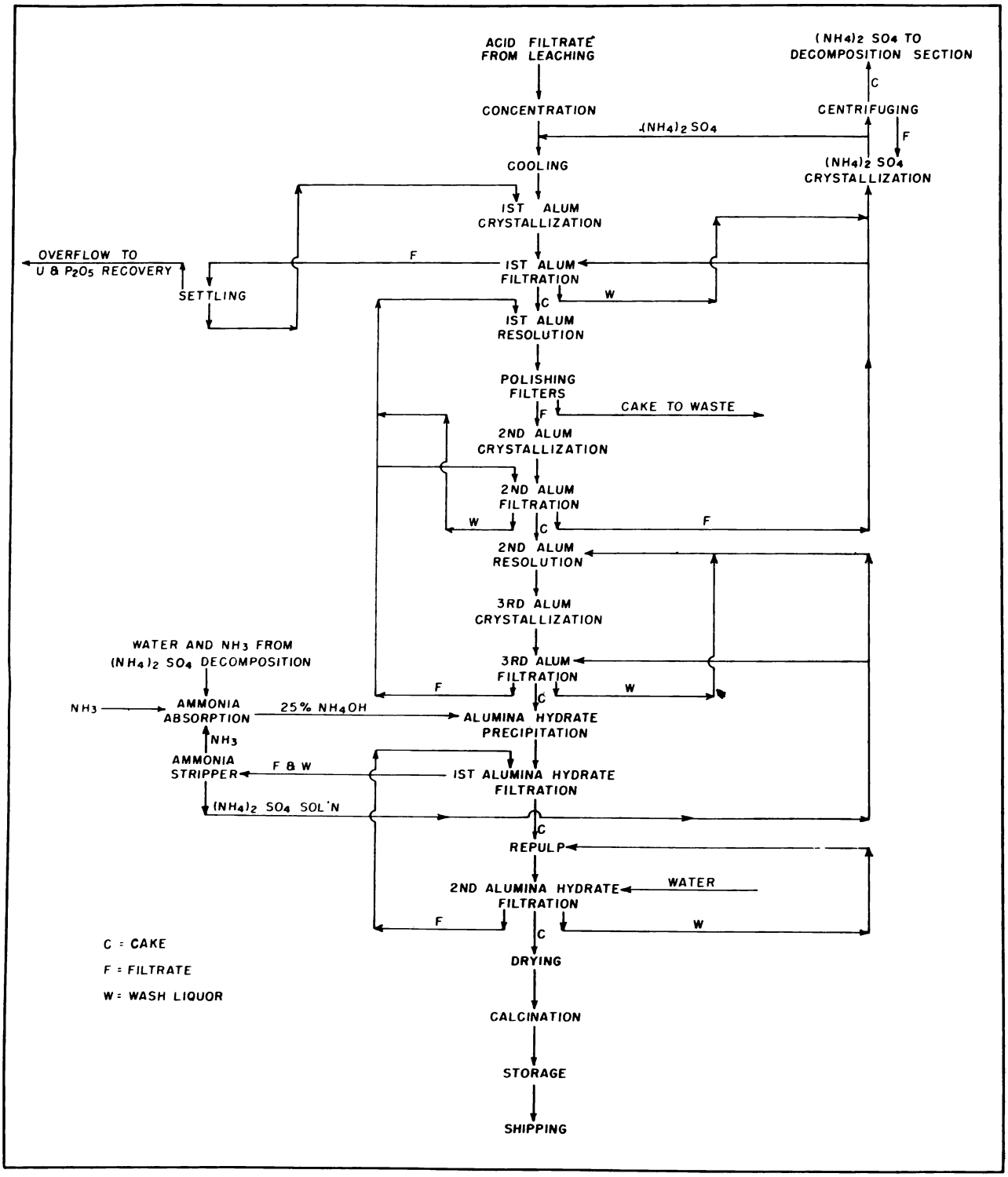
Preliminary investigation has been made for an alternate process which produces an impure alumina product suitable for feed to the Bayer process. In this process, alum is crystallized from the leached zone extract, filtered, washed, dissolved and passed through a spray dryer to dehydrate the alum.

The dehydrated alum is calcined to produce alumina and to recover sulfur values. The Ammonium Sulfate Decomposition Section is eliminated, but the capacity of the sulfuric acid and ammonia plants must be increased.

Cost estimates show that for a plant producing 450 tons uranium per year, using this alternate process, the total plant capital cost is $52,000,000 less and the total plant operating cost is $844 per hour less than the first process. However, the alumina product is not as pure as the alumina produced in the first process and, therefore, the sales value would be lower. The amount lost by the decrease in sales value would be greater than the amount gained by the decrease in operation costs. Better cost estimates could be obtained after this process is evaluated on a pilot plant scale.

FIGURE I

SIMPLIFIED FLOW SHEET
ALUMINA RECOVERY SECTION



III. PROCESS

A. BASIS OF THE PROCESS

1. Raw Materials

The process to recover metallurgical grade alumina, and to remove and recover ammonium sulfate formed by this operation, has been investigated in the laboratory and further developed in pilot plant operations. The principle raw materials required for this step are:

a. Clarified acid filtrate
b. Ammonia
c. Steam
d. Fuel oil

These raw materials will be discussed as follows:

a. Clarified Acid Filtrate

The acid filtrate containing the values solubilized by digestion is received from the Leaching Section after being clarified as described in Volume II, Leaching Section, of this series (RMO 2013). Filtrate received in the alumina recovery unit contains 22.7% solids. The weight per cent distribution of the values on a dry basis is as follows:

Weight Per Cent (Dry Basis)

Al_2O_3	P_2O_5	Fe_2O_3	SO_4	U_3O_8
22.1	18.0	2.59	47.2	.0287

Following is a breakdown of the estimated quantities of clarified acid filtrate feed to the three proposed alumina recovery units:

Clarified Acid Filtrate Requirements

Plant Size	Dissolved Solids	Water	G. P. M.	Sp. Gr.
450 Tons U/Year	213.2 T/Hr.	724.1 T/hr.	2989	1.26
225 Tons U/Year	106.6 T/Hr.	362.0 T/hr.	1490	1.26
100 Tons U/Year	47.3 T/Hr.	160.8 T/hr.	662	1.26

b. Ammonia

Ammonium hydroxide is used to precipitate alumina hydrate from the purified ammonium alum. A 25% solution of ammonia is preferred for this purpose. One hundred percent stoichiometric excess is fed to the precipitation tanks to assure complete reaction. Unreacted ammonia is recovered by means of a stripping column and returned to the precipitators.

Following is a table showing the sources of ammonia to the absorber:

Ammonia to Absorber, Tons/Hr. NH_3

Tons U/Year	450	225	100
From Stripper	47.2	23.6	10.5
From Decomposition Sec.	41.4	20.7	9.2
NH_3 from NH_3 Plant at Another Site	5.8	2.9	1.3
Total NH_3	94.4	47.2	21.0

c. Steam

Process steam is used to concentrate the clarified acid filtrate for steam jet cooling and crystallization, re-solution of alum, ammonia stripping and ammonium sulfate crystallization. All steam used will be back pressure steam from the electric power generating turbines. The source of the steam is described in the Utilities Report (RMO 2019).

Estimates of the steam requirements for the alumina recovery and ammonium sulfate crystallization for the three size plants are as follows:

	Process Steam, Pounds/Hour					
	450 Tons U/Yr.		225 Tons U/Yr.		100 Tons U/Yr.	
Unit Operation	100 psig Steam	15 psig Steam	100 psig Steam	15 psig Steam	100 psig Steam	15 psig Steam
$(NH_4)_2SO_4$ Crystallization	1,480	507,000	740	253,500	329	112,500
Evaporation of Acid Filtrate	285,675		143,175		63,550	
Steam Jet Cooling 1st Alum Cryst.	61,455		30,728		13,700	
1st Rediss. of Alum	135,000		62,500		30,000	
2nd Crystal. of Alum	397,590		198,795		88,376	
2nd Rediss. of Alum	36,000		18,000		8,000	
3rd Crystal. of Alum	407,650		203,825		90,589	
Ammonia Stripper		290,000		142,500		63,400
Total	1,324,850	797,000	657,763	396,000	294,544	175,900

d. Fuel Oil

Bunker C oil is proposed as fuel for drying the alumina hydrate cake and for calcining the dried cake to alumina.

The following table lists the estimated fuel oil requirements for the proposed plants:

Bunker C Fuel Oil Requirements, Gallons/Hour

Tons U/Year	450	225	100
Fuel Oil for Drying	5620	2810	1244
Fuel Oil for Calcining	1402	701	311
Total	7022	3511	1555

2. Ammonium Alum Crystallization & Purification

Acid filtrate received from the Leaching Section contains approximately 22% dissolved solids. It is advantageous to increase the percentage of dissolved solids before reacting with ammonium sulfate to form ammonium alum with the alumina sulfate present in the filtrate. However, concentration by evaporation is limited by the amount of water necessary to form alum-$(NH_4)_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$. Further evaporation, above approximately 30% solids, would reduce the yield.

Ammonium sulfate addition is of value up to a point where the solution is saturated with respect to both alum and ammonium sulfate. Beyond this point solid ammonium sulfate would crystallize and require removal in subsequent processing. This point is approximately three times the stoichiometric quantity of ammonium sulfate.

Alum is formed in a reaction between solid phase ammonium sulfate and dissolved aluminum sulfate in the leached zone liquor. Rate of solution of ammonium sulfate controls potential (degree of supersaturation) and rate of alum crystal growth so that well formed, relatively pure crystals, may be obtained.

Ammonium sulfate is added to 130° F. leached zone liquor, cooled to 77° F., and crystallized in 4-stage tank crystallizers (5 hours retention time). Discharge from the alum crystallizers is filtered and the filtrate containing the uranium and P_2O_5 values is pumped to the Uranium Recovery Section. In no case has alum precipitation interfered with U and P_2O_5 recovery in the filtrate. Cake from the first filtration

is dissolved and recrystallized twice. Ammonium sulfate solution is used for washing and is in countercurrent flow with the alum crystals. The wash solution is 20-25% ammonium sulfate from the alum-to-alumina conversion section and is therefore very pure since alum has low solubility in strong ammonium sulfate solutions (at normal temperatures).

Krystal units are provided for the second and third alum crystallization for the following reasons:

a. Crystallization is controlled.

(1.) Desired crystal size is produced
(2.) Controlled growth of crystals yields purer crystals

b. Operation is faster than with atmospheric or coil-type units.

3. Alumina Hydrate Precipitation & Filtration

The purified ammonium alum cake from the third alum filtration is reacted with two times the stoichiometric quantity of 25% aqua ammonia to convert the alum to alumina hydrate and to solubilize the ammonium sulfate released by the following reaction:

$$Al_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O + 6NH_4OH \xrightarrow{Aq.} Al_2O_3 \cdot xH_2O + 4(NH_4)_2SO_4$$

The quantity and strength of ammonia used has been determined experimentally as optimum for most complete conversion to the hydrate and for minimum inclusion of ammonium sulfate.

To assure a filterable precipitate of alumina hydrate, the above reaction is performed with minimum mechanical disturbance and sufficient time (3 hours) to permit the ammonia to penetrate the alum crystals for complete interaction.

The alumina hydrate is subjected to two filtrations with countercurrent washing to remove ammonia and ammonium sulfate from the cake.

4. Ammonia & Ammonium Sulfate Recovery

The filtrate and concentrated wash from the first alumina hydrate filtration is pumped to a stripping column for separation of the ammonia and ammonium sulfate. The ammonia overhead from the column is absorbed in the ammonia absorption unit and reused for alumina hydrate precipitation.

The stripping column bottom contains ammonium sulfate which is pumped to the ammonia sulfate crystallizer for concentration. The stream from the crystallizer is split; part is returned directly to the Alumina Section to form the ammonium alum and the remainder is centrifuged and forwarded to the Ammonium Sulfate Decomposition Section.

5. Drying & Calcining

The alumina hydrate received in the drying area will have the following composition:

Al_2O_3	13.7%
SO_4	2.3%
NH_3	0.7%
H_2O	83.3%

The wet cake is dried to a final temperature of 240° F. The drying operation eliminates most of the free water and ammonia.

The composition of the dryer discharge (calciner feed) is as follows:

Al_2O_3	58.6%
SO_4	9.9%
NH_3	.4%
Chemical Water	30.9%
Free Water	.1%

The calciner is operated at 2190° F. to remove the chemical water and the remainder of ammonia and sulfate to produce a metallurgi-

cal grade alumina with the following analysis:

Na_2O	Trace
Fe_2O_3	0.017%
SiO_2	0.021%
P_2O_5	0.0015%
TiO_2	.005%
CaO	.01%
H_2O Sorption	1.0%

The calcined alumina is stored in bins and shipped in bulk.

III. PROCESS

B. DETAILS OF THE PROCESS

1. Alumina Recovery

The attached flow diagrams for the alumina and aluminum sulfate recovery processes are numbered as follows:

Plant Size, Tons U/Year	Drawing Numbers
450	F-1-500 to F-1-504
225	F-2-500 to F-2-504
100	F-3-500 to F-3-504

After evaporation, the first step in alumina recovery consists of adding ammonium sulfate to the solution received from the Leaching Section. The resulting ammonium alum is freed from included P_2O_5 and other impurities by subjecting it to two crystallization and three filtration operations with countercurrent washes. The filtrate from the first filtration contains the U and P_2O_5 values and is sent to subsequent operations for their recovery. Alum from the final filtration is reacted with ammonium hydroxide to precipitate a crystalline alumina hydrate, which is easily filtered and washed free of ammonium sulfate in two filtrations. The hydrate is dried and calcined to metallurgical grade alumina. Ammonia and ammonium sulfate values are recovered as part of the process.

A more detailed explanation of the process follows:

Clear acid filtrate received from the Leaching Section, with 22% dissolved solids, is concentrated in the triple effect evaporator (EV-500) to 30% dissolved solids. Concentrated ammonium sulfate solution is added to the hot (130° F.) discharge from the final effect of the evaporators. The slurry is cooled to 77° F. in the steam jet refrigeration unit (SJ-500) and ammonium alum is then

crystallized from the slurry in the 4-stage crystallizer (T-500). Retention time in each crystallizer is five hours. Deep well water is circulated through the crystallizer cooling coils (E-502) to offset the heat of crystallization and maintain a temperature of 77° F.

Discharge from the final crystallizer is pumped to a distribution box (X-500) and flows from there to the first set of alum filters (F-501). Filtrate from the first alum filtration step is pumped to the filtrate surge and settling tank (T-508). Overflow from this tank is pumped to the Uranium Recovery Section; the underflow contains alum crystals and is returned to the fourth stage of the crystallizers (T-500). Filtrate from the second alum filtration is used to wash the horizontal filter cake and the washings are pumped to the ammonium sulfate removal unit. Cake from the first alum filtration is redissolved in wash liquor from the second alum filtration and filtrate from the third alum filtration. The 4-stage redissolving tanks (T-501) are steam heated to 160° F.

Hot (160° F.) liquor from the final redissolving tank is passed through a polishing filter (F-502) and collected in the filtrate surge tank (T-509). The cake from the polishing filter is discarded.

Filtrate from the surge tank is pumped to the steam jet refrigerated vacuum crystallizer (CR-501) which crystallizes the alum at 81° F.

Slurry from the crystallizers is pumped to the slurry distributor (X-502) and flows to the second alum filtration horizontal filters (F-503). The filtrate is pumped to the ammonium sulfate removal unit. Filter cake from this operation is washed with filtrate from the third alum filtration. This wash liquor is pumped to the first stage tank in the first re-solution of alum.

Cake from the second alum filtration is dissolved in ammonium sulfate solution from the ammonia stripper (K-501) and wash liquor from the third alum filtration in the second 4-stage re-solution of alum tanks (T-517). These tanks are steam heated to a discharge temperature of 160° F.

Redissolved alum is pumped to a distributor (X-504) and flows from the distributor to the third alum steam jet refrigerated crystallizer (CR-502). The cooled (81° F.) crystallized alum slurry is pumped to the slurry distributor (X-505) and flows from there to the third alum filtration filters (F-504). The filtrate is returned to the second alum filtration. Cake from the third filtration is washed with a cooled (81° F.) portion of the ammonium sulfate solution from the ammonia stripper (K-501) bottoms.

Alum cake from the third filtration is moved by screw conveyor (C-503) to the alumina hydrate precipitation tank (T-524). There ammonium alum crystals are reacted with 25% ammonia solution from the ammonia absorption column (K-500) to release ammonium sulfate to the solution and precipitate a crystalline alumina hydrate. Undissolved solids are conveyed by horizontal apron conveyors to the bottom of the precipitator and are removed by an inclined conveyor. Retention time in the precipitator is approximately 3 hours.

Precipitate and liquor from the precipitation tank are reunited in the slurry distributor (X-507) and flow to the first alumina hydrate filtration filter (F-505).

Filtrate from the second alumina hydrate filtration is recycled countercurrently through the filter cake for three washes. The concentrated wash is added to the filtrate in the filtrate surge tank (T-532) and is pumped to the ammonia stripper (K-501). Overhead from the ammonia stripper is cooled to 105° F. and sent to the ammonia absorber (K-500); the stripper bottom is pumped to the second set of alum re-solution tanks (T-517).

Cake from the first alumina hydrate filtration is reslurried in the repulping tanks (T-535). Repulped hydrate is pumped to a distributor (X-511) and flows to the second set of alumina hydrate filters (F-506). Clear water is recycled countercurrently through the cake to wash the cake three times. The concentrated wash liquor is pumped to the alumina hydrate repulping tanks.

Wet cake from the second alumina hydrate filtration is conveyed (C-505) to dryer feed bin (T-547) and fed to oil fired rotary dryers (D-500). A bucket elevator (L-500) raises the dried hydrate to calciner feed bin (T-548). The dried material is fed to the rotary calciner (D-501) and calcined to alumina at a final temperature of 2190° F. Hot calcined alumina is cooled to 400° F. in a rotary cooler (E-509) and discharged to a storage silo (T-549).

2. Ammonium Sulfate Removal

Filtrate from the second alum filtration is pumped to the ammonium sulfate crystallizer feed tank (T-501) and from there to the triple effect evaporator crystallizer (CR-500). The concentrated slurry from the crystallizer is centrifuged (F-500) and the cake is conveyed to the Ammonium Sulfate Decomposition Section. (RMO 2017) Filtrate from the centrifuge is returned to the crystallizer feed tank.

A portion of the slurry from the crystallizer is continuously added to the concentrated acid filtrate liquor to form ammonium alum.

3. Layout Drawings of the Alumina Section are attached and numbered as follows:

Plant Size, Tons U/Year	Drawing Numbers
450	L-1-500 and L-1-501
225	L-2-500 and L-2-501
100	L-3-500 and L-3-501

AMMONIUM SULFATE REMOVAL

C-1-500
1-WEIGH CONVEYOR BELT
18" WIDE x 300' LONG
5 HP DRIVE

CENTRIFUGE FEED
178.0 TONS/HR. SLURRY
486 GPM. SP.GR. -1.47

F-1-500A-C
3-CONTINUOUS CENTRIFUGES
8'-6" DIA. x 10'-10" LONG, EACH
50 HP EACH

WET CAKE TO T-1-800, SHEET F-1-800
52.3 TONS/HR., AMMONIUM SULFATE
1.0 TONS/HR., LIQUOR

LIQUOR FROM SECOND ALUM FILTRATION
FROM T-1-515, SHEET F-1-501
884.3 TONS/HR. LIQUOR 2971 GPM
SP.GR.-1.20

T-1-501

LIQUOR RECYCLE FROM CENTRIFUGE
124.7 TPH, LIQUOR
404 GPM SP.GR.-1.24

CRYSTALLIZER FEED
1008.9 TONS/HR, LIQUOR.
3375 GPM.
SP.GR.-1.20

P-1-508 A-E

T-1-501
1-CRYSTALLIZER FEED TANK
15 MIN. SURGE TIME
60,000 GAL. CAPACITY
22' DIA. x 21' HIGH

P-1-508 A-E
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
1015 GPM, MAX.
845 GPM, OPERATING
SP.GR.-1.20
35' HEAD 20 HP EACH

$(NH_4)_2SO_4$ RECYCLE STREAM
340.0 TONS/HR. SLURRY
926 GPM SP.GR.-1.47

CRYSTALLIZER PRODUCT
518.0 TONS/HR. SLURRY
1412 GPM SP.GR.-1.47

COOLING TOWER WATER
21,600 GPM @ 85°F

AMMONIUM SULFATE CRYSTALLIZATION

E-1-501A-L
12-EXCHANGERS
19,500 SQ.FT. EACH

FIRST EFFECT OVERHEAD
169.6 TONS/HR. WATER

CR-1-500A-L
4 STRINGS OF TRIPLE EFFECT
EVAPORATOR CRYSTALLIZERS
EACH CRYSTALLIZING UNIT - 26' DIA.

SECOND EFFECT OVERHEAD
156.3 TONS/HR, WATER

THIRD EFFECT OVERHEAD
165.0 TONS/HR., WATER

COOLING TOWER WATER
49,300 GPM @ 85°F

EJECTOR STEAM
1480 LBS./HR.
100 PSIG

BC-1-501 A-D
4-BAROMETRIC CONDENSERS

195°F
153°F
110°F
212°F
167°F
122°F

CR-1-500A-D
CR-1-500E-H
CR-1-5001-L

STEAM
507,000 LBS./HR.
15 PSIG

E-1-501 A-D
E-1-501 E-H
E-1-501 I-L

P-1-509A-E
P-1-510A-E
P-1-509F-J
P-1-510F-J
P-1-509K-O
P-1-510K-O
P-1-511A-E

CONDENSATE DISCHARGE
18,810 TONS/HR., WATER
51,200 GPM

P-1-509A-E
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
8460 GPM, MAXIMUM
7030 GPM, OPERATING
SP.GR.-1.47
25' HEAD, 125 HP EACH

P-1-510A-E
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
141 GPM, MAXIMUM
118 GPM, OPERATING
SP.GR.-1.20
125' HEAD, 10 HP EACH

P-1-509F-J
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
8460 GPM, MAXIMUM
7030 GPM, OPERATING
SP.GR.-1.47
25' HEAD, 125 HP EACH

P-1-510F-J
5-CENTRIFUGAL PUMPS
4-OPERATING, 1 SPARE
141 GPM., MAXIMUM
118 GPM., OPERATING
SP.GR.-1.20
125' HEAD, 10 HP. EACH

P-1-509K-O
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
8460 GPM., MAXIMUM
7030 GPM., OPERATING
SP.GR.-1.47
25' HEAD, 125 HP. EACH

P-1-510K-O
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
141 GPM., MAXIMUM
118 GPM., OPERATING
SP.GR. 1.20
125' HEAD, 10 HP. EACH

P-1-511A-E
5-CENTRIFUGAL PUMPS
4-OPERATING, 1-SPARE
15,350 GPM, MAXIMUM
12,800 GPM., OPERATING
SP.GR.-1.00
50' TOTAL HEAD, 250 HP. EACH

STEAM-JET COOLING

EJECTOR STEAM
455 LBS./HR, 100 PSIG

COOLING TOWER WATER
24,500 GPM @ 85°F

SJ-1-500 A-B
2-STEAM JET REFRIGERATING UNITS
2400 TONS OF REFRIGERATION EACH

WATER EVAPORATED
27.4 TONS/HR., WATER

BOOSTER STEAM
61,000 LBS/HR.
100 PSIG

SJ-1-500A-B

P-1-504 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
17,135 GPM., MAXIMUM
14,45 GPM., OPERATING
SP. GR. 1.42
50' HEAD, 50 HP EACH

P-1-504 A-C

P-1-505 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
19,820 GPM, MAXIMUM
12,350 GPM, OPERATING
SP. GR. 1.00
50' HEAD 275 HP. EACH

P-1-505 A-C

HOT WELL DISCHARGE
6188 TONS/HR., WATER
@ 55° F
24,700 GPM

EVAPORATION OF ACID FILTRATE

E-1-500A-F
6-EXCHANGERS
11,050 SQ. FT. EACH

EV-1-500 A-F
2-STRINGS-TRIPLE EFFECT
EVAPORATORS
EACH EVAPORATOR UNIT-26' DIA.

TOTAL OVERHEAD
226.3 TONS/HR. WATER

EJECTOR STEAM
675 LBS HR @ 100 PSIG

BC-1-500 A-B
2-BAROMETRIC CONDENSERS

STEAM
285,000 LBS/HR.
100 PSIG

189°F
150°F
130°F
338°F
200°F
160°F
130°F
130°F

E-1-500 A-B
E-1-500 C-D
E-1-500 E-F

EV-1-500A-B
EV-1-500C-D
EV-1-500E-F

EVAPORATOR DISCHARGE
2132 TPH DISSOLVED SOLIDS
497.8 TPH WATER
2074 GPM
SP.GR.-1.37

CLARIFIED ACID FILTRATE
FROM T-1-306, DWG. F-1-301
213.2 TONS/HR., DISSOLVED SOLIDS
724.1 TONS/HR. WATER
2980 GPM SP.GR.-1.26

110°F

FEED ANALYSIS
40.50 TPH P_2O_5
49.72 TPH Al_2O_3
5.82 TPH Fe_2O_3
128.60 TPH SO_4
0.0647 TPH U_3O_8

P-1-500A-D
P-1-501A-D
P-1-502A-D

P-1-500A-D
4-CENTRIFUGAL PUMPS
2-OPERATING, 2-SPARE
45,000 GPM., MAXIMUM
37,500 GPM., OPERATING
SP.GR.-1.30
20' HEAD, 400 HP EACH

P-1-501A-D
4-CENTRIFUGAL PUMPS
2-OPERATING, 2-SPARE
40,200 GPM, MAXIMUM
33,500 GPM, OPERATING
SP.GR.-1.34
20' HEAD, 350 HP EACH

P-1-502A-D
4-CENTRIFUGAL PUMPS
2-OPERATING, 2-SPARE
35,800 GPM, MAXIMUM
29,800 GPM, OPERATING
SP.GR.-1.37
20' HEAD, 325 HP EACH

CONDENSATE DISCHARGE
5627 TONS/HR. WATER
22,500 GPM

P-1-503 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
13,500 GPM., MAXIMUM
11,250 GPM., OPERATING
SP. GR.-1.0
50' HEAD, 225 HP. EACH

FIRST ALUM CRYSTALLIZATION

E-1-502 A-D
4-COOLING COILS
21,000 SQ. FT AREA EACH
70,700,000 BTU/HR. TOTAL

CRYSTAL RECYCLE FROM T-1-508, SHEET F-1-501
10.7 TONS/HR. ALUM - 105 GPM
24.9 TONS/HR. LIQUOR - SP.GR. 1.36

DEEP WELL WATER
35,000 GPM @ 72°F

77°F

T-1-500A
T-1-500B
T-1-500C
T-1-500D

E-1-502A
E-1-502B
E-1-502C
E-1-502D

R-1-500A
R-1-500B
R-1-500C
R-1-500D

FEED TO FILTERS F-1-501, SHEET F-1-501
1059.2 TONS/HR. SLURRY
2995 GPM SP.GR.-1.42

77°F

P-1-506A-B
P-1-506C-D
P-1-506E-F
P-1-507A-B

FEED TO FIRST ALUM CRYSTALLIZATION
1023.6 TONS/HR. SLURRY
2890 GPM SP.GR.-1.42

P-1-506A-F
6-CENTRIFUGAL PUMPS
3-OPERATING, 3-SPARE
3470 GPM, MAX.
2890 GPM, OPERATING
SP.GR.-1.42
30' HEAD, 60 HP EACH

P-1-507A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
3600 GPM, MAX.
2995 GPM, OPERATING
SP.GR.-1.40
50' HEAD, 100 HP EACH

T-1-500A-D
4-CRYSTALLIZERS
5 HRS. TOTAL RETENTION TIME
250,000 GAL. CAPACITY EACH
50' DIA. x 16' x 3' CONE

R-1-500A-D
4-RAKE MECHANISMS
15 HP EACH

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REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE	DATE	LOCATION OF JOB
F-1-501, PROCESS FLOW DIAGRAM-SHEET 2											DRAWN BY H.D.R - L.W.C.	3/21/52	
F-1-502, " " " " 3											CHECKED BY		
F-1-503, " " " " 4											CHECKED BY		
F-1-504, " " " " 5													

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
450 TON UNIT
SHEET 1 OF 5

APPR. NO.
DRWG. NO. F-1-500
FILE NO.

FIRST ALUM FILTRATION — FIRST REDISSOLVING OF ALUM — SECOND ALUM CRYSTALLIZATION — SECOND ALUM FILTRATION

$(NH_4)_2SO_4$ WASH TO T-1-501, DWG. F-1-500
884.2 TONS/HR. LIQUOR - 2371 GPM, SP.GR.-1.20

CRYSTALLIZER FEED FROM T-1-500, DWG. F-1-500
1059.2 TONS/HR. SLURRY
2995 GPM - SP.GR. 1.42

X-1-500 A-B
2-SLURRY DISTRIBUTORS
2-MIN. RESIDENCE TIME
3500 GAL. CAP. EACH
9' DIA. x 8'

X-1-501A-B
2-WASH LIQUOR DISTRIBUTORS
2-MIN. RESIDENCE TIME
1800 GAL. CAP. EACH
7' DIA. x 6'

77°F

X-1-500A-B

X-1-501A-B

C-1-501
1-BELT CONVEYOR
36" x 300'
10-H.P. DRIVE

F-1-501 A-P
16-HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE - 1.5 H.P.

F-1-501 A-P

FILTER CAKE
76.5 TONS/HR. LIQUOR
447.5 TONS/HR. ALUM

T-1-502
COMPRESSED AIR RECEIVER
5'-6" DIA. x 18'

T-1-503
VACUUM SCRUBBER
9' DIA. x 20'

C-1-501

77°F

T-1-510 A-D
4-ALUM REDISSOLVING TANKS
30 MIN. RESIDENCE TIME
50,000 GAL. CAPACITY EACH
20' DIA. x 20'

A-1-510 A-H
8-SIDE ENTERING AGITATORS
83 H.P. DRIVE, EACH.

T-1-510A
A-1-510A-D
E-1-503A

T-1-510B
A-1-510C-D
E-1-503B

T-1-510C
A-1-510E-F
E-1-503C

T-1-510D
A-1-510G-H
E-1-503D

E-1-503 A-D
4-STEAM COILS
6200 SQ. FT. AREA, EACH
134,300,000 BTU/HR. TOTAL

CR-501 A-T
20-VACUUM CRYSTALLIZERS
EACH UNIT - 26' D

SJ-1-501 A-T
20-STEAM JET REFRIGERATION UNITS
860 TONS OF REFRIGERATION EACH

EVAPORATED WATER
106.5 TONS/HR. WATER

COOLING TOWER WATER
92,500 GPM @ 85°F

HEATING STEAM
135,000 LBS/HR.
100 PSIG

EJECTOR STEAM
2550 LBS/HR. 100 PSIG

BOOSTER STEAM
985,000 LBS/HR
@ 100 PSIG

T-1-504 A-D

T-1-505 A-P

T-1-502

T-1-503

T-1-504 A-D
16-FILTRATE RECEIVERS
1-MIN. RESIDENCE TIME EA.
11.7 GAL. CAP. EACH
2' DIA. x 5'

T-1-505 A-P
16-WASH RECEIVERS
1-MIN. RESIDENCE TIME EA.
11.7 GAL. CAPACITY EACH
2' DIA. x 5'

FEED TO POLISHING FILTERS
1518.7 TONS/HR. LIQUOR
4706 GPM SP.GR. 1.27

WASH LIQUOR
445.0 TONS/HR. LIQUOR
1480 GPM
SP.GR. 1.20

P-1-515 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
5650 GPM MAX.
4706 GPM OPERATING
SP.GR. 1.27 300 H.P. EACH
125' HEAD

X-1-502A-B
2-LIQUOR DISTRIBUTORS
1-MIN. RESIDENCE TIME
8825 GAL CAP. EACH
8' DIA. x 8'

SJ-1-501A-T

CR-1-501A-T

81°F

160°F

X-1-502A-B

FILTRATE
10.7 TONS/HR. ALUM CRYSTALS 1630 GPM
524.5 TONS/HR. LIQUOR SP.GR. 1.27

T-1-506A-B

T-1-507A-B

T-1-507A-B
2-WASH LIQUOR SURGE TANKS
5-MIN. RESIDENCE TIME EACH
5000 GAL. CAPACITY EACH
8' x 8' x 10' DEEP

T-1-506 A-B
2-FILTRATE SURGE TANKS
5-MIN. RESIDENC TIME, EA.
5000 GAL. CAP. EACH
8'x 8'x 10' DEEP.

F-1-502A-E

F-1-502F-J

AC-1-500
AIR COMPRESSOR
6000 CFM
750 H.P.

VP-1-500
1-VACUUM PUMP
40,000 CFM
1500 H.P.

P-1-512 A-C

P-1-513 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
880 G.P.M. MAX.
740 GPM OPERATING
SP.GR. 1.20 - 20 H.P. EACH
50' HEAD

F-1-502 A-J
10-POLISHING FILTERS
5-OPERATING, 5-OFF-STREAM
1304 SQ. FT. EACH

P-1-517 A-U
21-CENTRIFUGAL PUMPS
20-OPERATING, 1-SPARE
9100 GPM MAX. EACH
7580 GPM OPERATING
SP.GR. 1.32
25' HEAD; 100 H.P. EACH

FEED TO URANIUM RECOVERY
T-1-502, DWG. F-1-500
499.6 TONS/HR. LIQUID
1576 GPM SP. GR.-1.27

COMPOSITION		
SO_4	92.41	TONS/HR.
NH_3	31.10	TONS/HR.
P_2O_5	40.50	TONS/HR.
Al_2O_3	2.49	TONS/HR.
Fe_2O_3	5.82	TONS/HR.
U_3O_8	0.0647	TONS/HR.

3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
1010 GPM MAX. EACH
840 GPM OPERATING
SP.GR. 1.27
50' HEAD 25 H.P. EACH

77°F

T-1-508

R-1-508

P-2-542 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1890 GPM, MAX.
1576 GPM, OPERATING
SP. GR. - 1.27
100' HEAD - 100 HP EACH

P-2-542 A-B

T-1-508
FILTRATE SURGE & SETTLING TANK
5-HOUR RESIDENCE TIME
500,000 GAL. CAPACITY
50' DIA. x 34'

R-1-508
SETTLING RAKE
65 H.P. DRIVE

T-1-509

T-1-509
FILTRATE SURGE TANK
5-MIN. RESIDENCE TIME
28,000 GAL CAPACITY EA.
17' DIA x 17'

P-1-518 A-U
21-CENTRIFUGAL PUMPS
20-OPERATING, 1-SPARE
260 GPM MAX. EACH
212 GPM OPERATING
SP.GR. 1.32
50' HEAD 10 H.P. EACH

HOT WELL DISCHARGE
23,400 TONS/HR. WATER
93,700 GPM @ 93°F

P-1-519 A-F
6-CENTRIFUGAL PUMPS
5-OPERATING, 1-SPARE
22,500 GPM MAXIMUM
18,150 GPM OPERATING
SP.GR. 1.0
50' HEAD 350 H.P. EACH

CRYSTAL RECYCLE TO T-1-500
DWG. F-1-500
10.7 TONS/HR. ALUM CRYSTALS 105 GPM
24.9 TONS/HR. LIQUOR - SP.GR. 1.36

P-1-514 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
126 GPM MAX. EACH
105 GPM OPERATING
SP.GR. 1.36
50' HEAD 5 H.P. EACH

P-1-516 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
5650 GPM MAX.
4706 GPM OPERATING
SP.GR. 1.27
50' HEAD 125 H.P. EACH

FEED TO ALUM CRYSTALLIZERS
1518.7 TONS/HR. LIQUOR
4706 GPM SP.GR. 1.27

FILTRATE FROM THIRD ALUM FILTRATION
545.7 TONS/HR. 1850 GPM SP.GR. 1.18

WASH LIQUOR TO 1ST ALUM FILTRATION
445.0 TONS/HR. LIQUOR
1480 GPM SP.GR. 1.20

FILTER FEED
1412.2 TONS/HR. SLURRY
4280 GPM SP.GR. 1.32

FILTRATE FROM THIRD ALUM FILTRATION
T-1-522, DWG. F-1-502
934.7 TONS/HR. LIQUOR - 3370 GPM - SP.GR. 1.18

X-1-502 A-B
SLURRY DISTRIBUTORS
2-MIN. SURGE TIME
5,150 GAL. CAPACITY EACH
10' DIA. x 9' HIGH

X-1-503 A-B
WASH LIQUOR DISTRIBUTOR
2-MIN. SURGE TIME
1820 GAL. CAP. EACH
7' DIA x 6' HIGH

X-1-502 A-B

X-1-503 A-B

WASH LIQUOR TO 2ND ALUM FILTRATION
449.0 TONS/HR. LIQUOR
1520 G.P.M. 1.18 SP.GR.

FILTER CAKE TO T-1-513 DWG. F-1-502
76.7 TONS/HR. LIQUOR
451.3 TONS/HR. ALUM

F-1-503 A-M
13-HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE - 1.5 H.P.

F-1-503 A-M

C-1-502
1-BELT CONVEYOR
36" WIDE x 200' LONG.
10 H.P. DRIVE

T-1-511

T-1-512 A-B

T-1-513 A-M

T-1-514 A-M

T-1-511
COMPRESSED AIR RECEIVER
5'-6" DIA. x 18'

T-1-512
1-VACUUM SCRUBBER
9' DIA. x 20'

T-1-513 A-M
13-FILTRATE RECEIVERS
1-MIN. RESIDENCE TIME EA.
27.5 GAL. CAP. EACH
3' DIA. x 5'-6"

T-1-514 A-M
13-WASH RECEIVERS
1-MIN. RESIDENCE TIME EA.
140 GAL. CAP. EACH
2' DIA. x 6'

WASH LIQUOR
449.0 TONS/HR. LIQUOR
1520 G.P.M SP.GR. 1.18

T-1-515 A-B

T-1-516 A-B

T-1-515 A-B
2-FILTRATE SURGE TANKS
5-MIN. RESIDENCE TIME EA.
9000 GAL. CAP. EACH
10' x 10' x 12' DEEP

T-1-516 A-B
2-WASH LIQUOR SURGE TANKS.
5-MIN. RESIDENCE TIME EA.
4500 GAL. CAP. EACH
8' x 8' x 10' DEEP

AC-1-501
AIR COMPRESSOR
6,000 CFM
750 H.P.

VP-1-501
1-VACUUM PUMP
40,000 CFM
1500 H.P.

FILTRATE
884.2 TONS/HR. LIQUOR - 2971 GPM, SP.GR. 1.20

P-1-520 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
1785 GPM MAXIMUM
1488 GPM OPERATING
SP.GR. 1.20 50 H.P. EACH
50' HEAD

P-1-521 A-C

P-1-521 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
915 GPM MAXIMUM
760 GPM OPERATING
SP.GR. 1.18 - 20 H.P. EACH
50' HEAD

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REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE

SCALE	DATE	LOCATION OF JOB
DRAWN BY H.L.S.-E.R.D.	5/14/53	
CHECKED BY		
CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
450 TON UNIT
SHEET 2 OF 5

APPN. NO.
DRWG. NO. F-1-501
FILE NO.

SECOND REDISSOLVING OF ALUM

THIRD ALUM CRYSTALLIZATION

THIRD ALUM FILTRATION

$Al(OH)_3$ PRECIPITATION

NH_4OH MAKE-UP

LIQUOR FROM THIRD ALUM FILTRATION TO F-1-503, SHEET F-1-501
994.7 TONS/HR., LIQUOR
3370 GPM SP. GR. - 1.18

23.5 WT % $(NH_4)_2SO_4$ SOLUTION
495.9 TONS/HR., WATER 2322 GPM
153.2 TONS/HR., $(NH_4)_2SO_4$ SP. GR. - 1.14

FILTER CAKE FROM C-1-502, SHEET F-1-501
451.3 TONS/HR ALUM
76.7 TONS/HR., LIQUOR

81°F

T-1-517A
A-1-517A-B
E-1-509A
T-1-517B
A-1-517C-D
E-1-509B
T-1-517C
A-1-517E-F
E-1-509C
T-1-517D
A-1-517G-H
E-1-509D

T-1-517A-D
4 - ALUM RESOLUTION TANKS
30 MIN. TOTAL RETENTION TIME
46,000 GAL. CAPACITY EACH
20' DIA. x 20'

A-1-517A-H
8-SIDE ENTERING AGITATORS
25 H.P. DRIVE EACH

E-1-5C & A-D
4-STEAM COILS
1655 SQ. FT. AREA EACH
38,800,000 BTU/HR.

X-1-504 A-B
2- DISTRIBUTORS
2-MIN. RETENTION TIME
6250 GAL. CAPACITY EACH
11'-0" DIA. x 9'

FEED TO ALUM CRYSTALLIZER
1608.0 TONS/HR., LIQUOR
5106 GPM SP. GR. - 1.26

STEAM 36,000 LBS./HR. @ 100 PSIG

COOLING TOWER WATER 94,600 GPM @ 85°F

WATER EVAPORATED 109.0 TONS/HR., WATER

BOOSTER STEAM 405,000 LBS/HR., @ 100 PSIG

SJ-1-502 A-V

EJECTOR STEAM 2650 LBS/HR., @ 100 PSIG

160°F

X-1-504 A-B

P-1-522 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
6130 GPM MAXIMUM
5106 GPM OPERATING
SP. GR. 1.26 150 H.P. EACH
50' HEAD

CR-1-502 A-V

WASH FROM 3RD. ALUM FILTRATION
319.2 TONS/HR., WATER
98.4 TONS/HR., $(NH_4)_2SO_4$
13.3 TONS/HR., ALUM
1438 GPM SP. GR. - 1.14

P-1-523 A-W
23-CENTRIFUGAL PUMPS
22-OPERATING, 1-SPARE
9200 GPM MAX. EACH
8000 GPM OPERATING
SP. GR. 1.26 125 H.P. EACH
25' HEAD

81°F

P-1-528 A-W
23-CENTRIFUGAL PUMPS
22-OPERATING, 1-SPARE
225 GPM, MAXIMUM
212 GPM, OPERATING
SP. GR. - 1.28 10 HP EACH
50' HEAD

HOT WELL DISCHARGE
23,950 TONS/HR. WATER
95,840 GPM @ 99°F

P-1-525 A-F
6-CENTRIFUGAL PUMPS
5-OPERATING, 1-SPARE
23,000 GPM, MAXIMUM
19,150 GPM, OPERATING
SP. GR. - 1.00
50' HEAD 375 H.P. EACH

FILTER FEED
1499.0 TONS/HR., SLURRY
4670 GPM. SP. GR. - 1.28

F-1-504 A-M
13-HORIZONTAL FILTERS
15' DIA. EACH
3-H.P. DRIVE EACH
SCROLL DISCHARGE - 1.5 W.P.

X-1-505 A-B
2- SLURRY DISTRIBUTOR
2 MIN. RETENTION TIME
5,600 GAL. CAPACITY
11' DIA. x 8' HIGH

X-1-506 A-B
2-WASH LIQUOR DISTRIBUTORS
2-MIN. RETENTION TIME
1725 GAL. CAPACITY
7' DIA. x 6' HIGH

AC-1-502
1 AIR COMPRESSOR
6,000 CFM
750 H.P.

VP-1-502
1-VACUUM PUMP
40,000 CFM
1500 HP

T-1-518
T-1-519
VACUUM SCRUBBER
9' DIA. x 20'
T-1-520 A-M
T-1-521 A-M

T-1-518
COMPRESSED AIR SURGE TANK
3'-6" DIA. x 18'

T-1-521 A-M
13-WASH LIQUOR RECEIVERS
1-MIN. RETENTION TIME EACH
132 - GAL. CAPACITY EACH
2' DIA. x 6'

T-1-520 A-M
13-FILTRATE RECEIVERS
1-MIN. RETENTION TIME EACH
315 GAL. CAPACITY EACH
3' DIA. x 6'

T-1-522 A-B
T-1-523 A-B

P-1-526 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
2010 GPM MAXIMUM
1685 GPM OPERATING
SP. GR. 1.181 50 H.P. EACH
50' HEAD

T-1-522 A-B
2-FILTRATE SURGE TANKS
5 MIN. RETENTION TIME
10,000 GAL. CAP. EACH
11' x 11' x 11' DEEP

P-1-527 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
865 GPM MAXIMUM
713 GPM OPERATING
SP. GR. 1.18 20 H.P. EACH
50' TOTAL HEAD

T-1-523 A-B
2-WASH LIQUOR SURGE TANKS
5 MIN. RETENTION TIME
4300 GAL. CAPACITY EACH
8'x8'x9' DEEP

P-1-526 A-C
P-1-527 A-C

AMMONIUM SULFATE SOLUTION @ 81°F FROM K-1-501, SHEET F-1-503
319.2 TONS/HR., WATER 1438 GPM
98.4 TONS/HR., $(NH_4)_2SO_4$ SP. GR. - 1.14

AMMONIUM SULFATE SOLUTION @ 212°F FROM K-1-501, SHEET F-1-503
495.9 TONS/HR., WATER 2322 GPM
153.2 TONS/HR., $(NH_4)_2SO_4$ SP. GR. - 1.14

FILTER CAKE
417.6 TONS/HR. ALUM CRYSTALS
2.4 TONS/HR. ALUM IN SOLUTION
17.3 TONS/HR. $(NH_4)_2SO_4$ IN SOLUTION
53.7 TONS/HR. WATER

25% NH_3 FEED
94.4 TONS/HR. NH_3
283.1 TONS/HR. WATER
SP. GR. 0.91

FEED TO F-1-505, SHEET F-1-503
47.2 TONS/HR. NH_3
262.3 TONS/HR. $(NH_4)_2SO_4$
72.2 TONS/HR. $Al(OH)_3$
486.8 TONS/HR. WATER
2870 GPM SP. GR. 1.21

C-1-503 A-M
13-SCREW CONVEYORS
24" DIA. x 20' LONG
7500 CU. FT./HR. SOLIDS
10 H.P. DRIVE 55 RPM

C-1-503 A-M

T-1-524 A-M

P-1-528 A-N

T-1-524 A-M
13-PRECIPITATION TANKS
12'-WIDE x 85' LONG x 30' DEEP
3-HRS. RETENTION TIME
8 HORIZ. APRON CONVEYOR (FLIGHTS ATTACHED) PER TANK
1-INCLINED APRON CONVEYOR (FLIGHTS ATTACHED) PER TANK
12' WIDE x 80' LONG - 6" FLIGHTS, EACH

P-1-528 A-N
14-CENTRIFUGAL PUMPS
13-OPERATING, 1-SPARE
240 GPM., MAXIMUM
200 GPM., OPERATING
SP. GR. - 1.00
50' HEAD 5 H.P. EACH

FILTRATE
994.7 TONS/HR., LIQUOR
3370 GPM. SP. GR. - 1.18

WASH AMMONIUM SOLUTION FROM T-1-B, SHEET F-1-501
41.4 TONS/HR. NH_3, 1325 GPM
283.1 TONS/HR. WATER. SP. GR. - 0.581

K-1-500

NH_3 MAKE-UP
6.8 TONS/HR. NH_3
38.8 GPM
SP. GR. 0.597

T-1-525 A-B

P-1-529
1-CENTRIFUGAL PUMP
1000 GPM, OPERATING
SP. GR. - 0.597
100' HEAD
25 H.P.

T-1-525 A-B
2-LIQUID NH_3 STORAGE TANKS
8 HR. TOTAL CAPACITY
14,000 GALS. EACH
6'-6" DIA. x 26' LONG

P-1-530 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2000 GPM, MAXIMUM
1660 GPM, OPERATING
SP. GR. - 0.31 30 H.P. EACH
50' HEAD

K-1-500
AMMONIA ABSORPTION COLUMN
13'-6" DIA. x 50'

AMMONIA FROM K-1-501, SHEET F-1-503
47.2 TONS/HR., NH_3

WASH LIQUOR FROM 3 RD ALUM FILTER
319.2 TONS/HR. WATER
98.4 TONS/HR. $(NH_4)_2SO_4$
13.3 TONS/HR. ALUM
1438 GPM
SP. GR. 1.141

25

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE
F-1-500 · PROCESS FLOW - SHEET No. 1										
F-1-501 " " - " No. 2										
F-1-503 " " - " No. 4										
F-1-504 " " - " No. 5										

SCALE
DRAWN BY H.D.R. EPP 5/14/63
CHECKED BY
CHECKED BY

LOCATION OF JOB

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
450 TON UNIT
SHEET 3 OF 5

APPN. NO.
DRWG. NO. F-1-502
FILE NO.

~ FIRST $AL(OH)_3$ FILTRATION ~

~ $AL(OH)_3$ REPULPING ~

~ SECOND $AL(OH)_3$ FILTRATION ~

~ AMMONIA RECOVERY ~

FEED FROM T-1-524, DWG. F-1-502
868.5 TONS/HR. SLURRY, 2870 GPM
SP.GR. - 1.21

COMPOSITION :-
FREE NH_3 - 47.2 TONS/HR.
$(NH_4)_2SO_4$ - 262.3 TONS/HR.
$AL(OH)_3$ - 72.2 TONS/HR.
WATER - 486.8 TONS/HR.

X-1-507 A-B
SLURRY DISTRIBUTORS
2 MIN. RESIDENCE TIME
3450 GALS. CAPACITY, EACH
9' DIAM. x 7'

X-1-508 A-B
WASH LIQUOR DISTRIBUTORS
2 MIN. RESIDENCE TIME
2800 GAL. CAPACITY, EACH
9' DIAM. x 6'

X-1-509 A-B
WASH LIQUOR DISTRIBUTORS
2 MIN. RESIDENCE TIME
2800 GALS. CAPACITY, EACH
9' DIAM. x 6'

X-1-510 A-B
WASH LIQUOR DISTRIBUTORS
2 MIN. RESIDENCE TIME
2800 GAL. CAP. EACH
9' DIAM. x 6'

WASH LIQUOR
599.1 TONS/HR. LIQUOR
11.1 TONS/HR. NH_3 2306 GPM
26.8 TONS/HR. SO_4 SP.GR. - 1.04

RESOLUTION LIQUOR
608.8 TONS/HR., TOTAL LIQUOR
5.5 TONS/HR. NH_3 2400 GPM
13.4 TONS/HR. SO_4 SP.GR. - 1.02

F-1-505 A-M
13 - HORIZONTAL FILTERS
15' DIAM. EACH
3 HP DRIVE EACH
1.5 HP SCROLL DISCHARGE

C-1-504
1 - CONVEYOR BELT
30" x 200' LONG
10 HP

FILTER CAKE
353.7 TONS/HR. TOTAL WET CAKE
13.7 TONS/HR. NH_3
34.9 TONS/HR. SO_4

T-1-535 A
A-1-535A-B

T-1-535 B
A-1-535C-D

T-1-535 C
A-1-535E-F

T-1-535A-C
3 - REPULPING TANKS
5 MIN. RETENTION TIME TOTAL
21,300 GAL. CAP. EACH
15' DIAM. x 16' EACH

A-1-535A-F
6 - SIDE ENTERING AGITATORS
15 HP EACH

T-1-526
T-1-527

T-1-528 A-M
T-1-529 A-M
T-1-530 A-M
T-1-531 A-M

T-1-526
1 - COMPRESSED AIR SURGE TANK
5'-6" DIAM. x 18'

T-1-527
1 - VACUUM SCRUBBER
9' DIAM. x 20'

T-1-528A-M
13 - FILTRATE RECEIVERS
1 - MIN. RESIDENCE TIME
170 GAL. CAPACITY, EACH
2'-6" DIAM. x 5'

T-1-529A-M
13 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
215 GAL. CAPACITY, EACH
2'-6" DIAM. x 6'

T-1-530A-M
13 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
215 GAL. CAP.
2'-6" DIAM. x 6

T-1-531 A-M
13 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
215 GAL. CAP.
2'-6" DIAM. x 6'

FILTRATE
505.5 TONS/HR. LIQUOR
90.1 TONS/HR. NH_3 1845 GPM
129.1 TONS/HR. SO_4 SP.GR. - 1.09

FINAL WASH SOLUTION
608.4 TONS/HR. LIQUOR
22.1 TONS/HR. NH_3 2280 GPM
53.6 TONS/HR. SO_4 SP.GR. - 1.07

NO. 2 WASH

NO. 1 WASH

T-1-532 A-B
T-1-533 A-B
T-1-534 A-B

AC-1-503
1 - AIR COMPRESSOR
6000 CFM
750 HP

VP-1-503
1 - VACUUM PUMP
40,000 CFM
1500 HP

P-1-531 A-C
P-1-532 A-C
P-1-533 A-C

T-1-532A-B
2 - FILTRATE SURGE TANKS
5 MIN. RESIDENCE TIME
12,200 GAL. CAPACITY, EACH
11' x 11' x 14' DEEP

T-1-533A-B
2 - WASH SURGE TANKS
2 MIN. RESIDENCE TIME
7000 GAL. CAP.
10' x 10' x 10' DEEP

T-1-534A-B
2 - WASH SURGE TANKS
2 MIN. RESIDENCE TIME
7000 GAL. CAP.
10' x 10' x 10' DEEP

FILTRATE
1113.9 TONS/HR. LIQUOR
251.6 TONS/HR. $(NH_4)_2SO_4$
47.2 TONS/HR. NH_3 4125 GPM
815.1 TONS/HR. WATER SP.GR. - 1.09

P-1-534 A-B

P-1-531 A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
2440 GPM, MAX.
2063 GPM, OPERATING
SP.GR. - 1.09
50' HEAD, 50 HP EACH

P-1-532 A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
1330 GPM, MAX.
1160 GPM, OPERATING
SP.GR. - 1.06
50' HEAD, 30 HP EACH

P-1-533 A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
1390 GPM, MAX.
1160 GPM, OPERATING
SP.GR. - 1.04
50' HEAD, 30 HP EACH

P-1-534 A-B
2 - CENTRIFUGAL PUMPS
1 - OPERATING, 1 - SPARE
4260 GPM, MAX.
3549 GPM, OPERATING
SP.GR. - 1.09
50' HEAD, 75 HP EACH

X-1-511 A-B
SLURRY DISTRIBUTORS
2 MIN. RESIDENCE TIME
4250 GAL. CAPACITY, EACH
9' DIAM. x 9'

X-1-512 A-B
WASH LIQUOR DISTRIBUTORS
2-MIN. RESIDENCE TIME
2850 GAL. CAPACITY, EACH
8' DIAM. x 8'

X-1-513 A-B
WASH LIQUOR DISTRIBUTORS
2-MIN. RESIDENCE TIME
2850 GAL. CAPACITY, EACH
8' DIAM. x 8'

X-1-514 A-B
WATER WASH DISTRIBUTORS
2-MIN. RESIDENCE TIME
2850 GAL. CAPACITY, EACH
8' DIAM. x 8'

FILTER FEED
962.5 TONS/HR. TOTAL SLURRY
19.2 TONS/HR. NH_3 3549 GPM
48.3 TONS/HR. SO_4 SP.GR. - 1.09

WATER WASH
589.9 TONS/HR., WATER
2360 GPM

F-1-506A-J
10 - HORIZONTAL FILTERS
15' DIAM. EACH
3 HP DRIVE EACH
1.5 HP SCROLL DISCHARGE

T-1-539A-J
10 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

C-1-505
1 - CONVEYOR BELT
30" x 300' LONG
10 HP

WET CAKE TO T-1-547, DWG. F-1-504
344.5 TONS/HR. TOTAL WET CAKE
COMPOSITION :-
Al_2O_3 - 47.2 TONS/HR.
SO_4 - 9.1 TONS/HR.
NH_3 - 2.6 TONS/HR.
H_2O - 261.6 TONS/HR.

T-1-536
T-1-537
T-1-538 A-J
T-1-539 A-J
T-1-540 A-J
T-1-541 A-J

T-1-536
1 - COMPRESSED AIR SURGE TANK
5'-6" DIAM. x 18'

T-1-537
1 - VACUUM SCRUBBER
9' DIAM. x 20'

T-1-540A-J
10 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

T-1-541A-J
10 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

T-1-538A-J
10 - FILTRATE RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

STRIPPER FEED
1113.9 TONS/HR. TOTAL LIQUOR
251.6 TONS/HR. $(NH_4)_2SO_4$
47.2 TONS/HR. NH_3 4125 GPM
815.1 TONS/HR. WATER SP.GR. - 1.09

72°F
DEEP WELL WATER
3000 GPM @ 72°F

E-1-505
105°F

AMMONIA TO K-1-500, DWG. F-1-502
47.2 TONS/HR. NH_3

E-1-505
1 - HEAT EXCHANGER
10,000 SQ. FT.

K-1-501
1 - AMMONIA STRIPPING COLUMN
7' DIAM. x 50'

FILTRATE
599.1 TONS/HR. TOTAL LIQUOR
11.1 TONS/HR. NH_3 2306 GPM
26.8 TONS/HR. SO_4 SP.GR. - 1.04

NO. 3 WASH

NO. 2 WASH

NO. 1 WASH

FINAL WASH SOLUTION
608.8 TONS/HR. LIQUOR
5.5 TONS/HR. NH_3 2400 GPM
13.4 TONS/HR. SO_4 SP.GR. - 1.02

T-1-542 A-B
T-1-543 A-B
T-1-544 A-B
T-1-545 A-B

AC-1-504
1 - AIR COMPRESSOR
4000 CFM,
500 HP,

VP-1-504
1 - VACUUM PUMP
30,000 CFM
1250 HP

P-1-535A-C
P-1-536A-C
P-1-537A-C
P-1-538A-C

T-1-542A-B
2 - FILTRATE SURGE TANKS
5 - MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-1-543A-B
2 - WASH SURGE TANKS
5 - MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-1-544A-B
2 - WASH SURGE TANKS
5 - MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-1-545A-B
2 - WASH SURGE TANKS
5 - MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

P-1-535A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
1385 GPM, MAX.
1155 GPM, OPERATING
SP.GR. - 1.04
50' HEAD, 30 HP EACH

P-1-536A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
1440 GPM, MAX.
1200 GPM, OPERATING
SP.GR. - 1.02
50' HEAD, 30 HP EACH

P-1-537A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
1430 GPM, MAX.
1190 GPM, OPERATING
SP.GR. - 1.01
50' HEAD, 30 HP EACH

P-1-538A-C
3 - CENTRIFUGAL PUMPS
2 - OPERATING, 1 - SPARE
1420 GPM, MAX.
1180 GPM, OPERATING
SP.GR. - 1.0
50' HEAD, 30 HP EACH

DEEPWELL WATER
5200 GPM @ 72°F

P-1-539A-B
2 - CENTRIFUGAL PUMPS
1 - OPERATING, 1 - SPARE
4510 GPM, MAX.
3760 GPM, OPERATING
SP.GR. - 1.14
100' HEAD, 150 HP EACH

P-1-539A-B

E-1-506
1 - HEAT EXCHANGER
12,300 SQ. FT.

STEAM
290,000 LBS./HR.
@ 15 PSIG

E-1-507
1 - HEAT EXCHANGER
13200 SQ. FT.

212°F
81°F
E-1-507

AMMONIUM SULFATE SOLUTION TO X-1-506, DWG. F-1-502
319.2 TONS/HR. WATER
98.4 TONS/HR. $(NH_4)_2SO_4$
143 GPM SP.GR. - 1.14

212°F

AMMONIUM SULFATE SOLUTION TO T-1-517, DWG. F-1-502
495.9 TONS/HR. WATER 2322 GPM
153.2 TONS/HR. $(NH_4)_2SO_4$ SP.GR. - 1.14

REFERENCE DRAWINGS	
F-1-500, PROCESS FLOW DIAG	SHEET 1
F-1-501, " " " "	2
F-1-502, " " " "	3
F-1-504, " " " "	5

MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE

SCALE	DATE	LOCATION OF JOB
DRAWN BY L.W.C.	6-11-53	
CHECKED BY		
CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

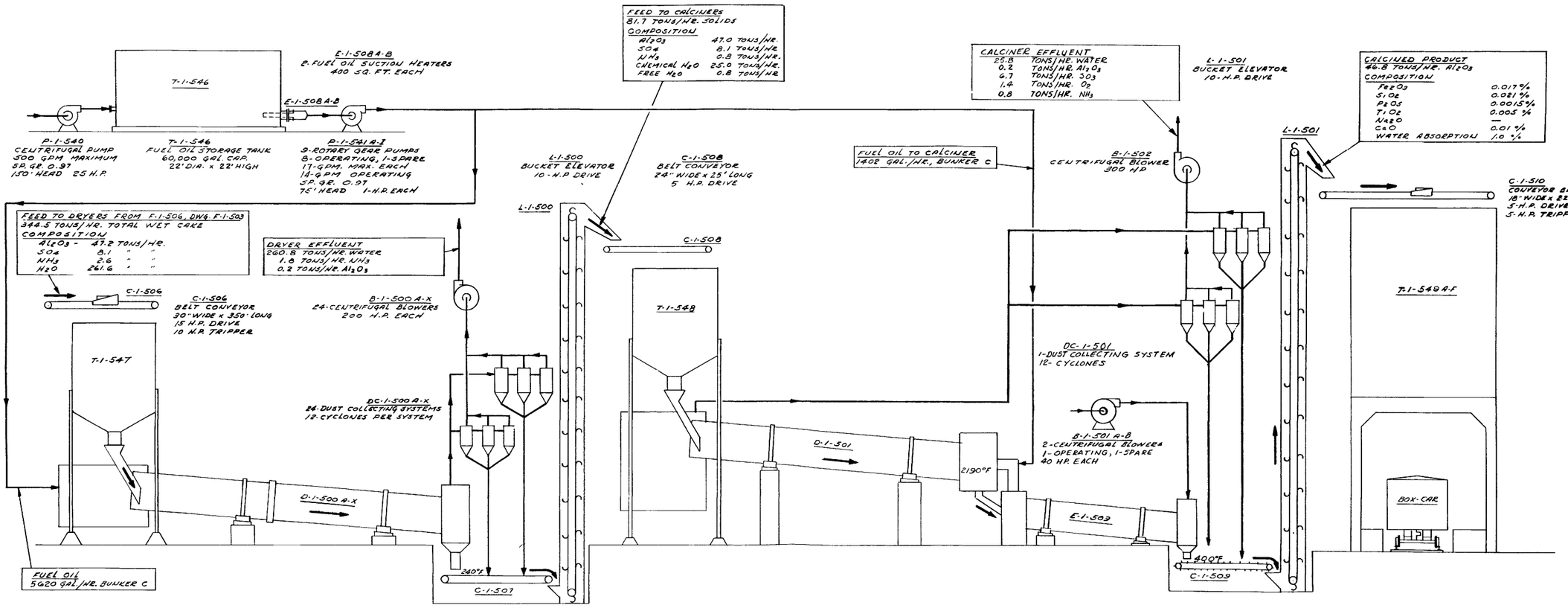
TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
450 TON UNIT
SHEET 4 OF 5

APPN. NO.
DRWG. NO. F-1-503
FILE NO.

DRYING

CALCINING & COOLING

STORAGE & SHIPPING



T-1-547
DRYER FEED BIN
24-CONE BOTTOMS WITH BIN FEEDERS
8 HOUR STORAGE CAPACITY
15' x 20' DEEP x 360' LONG

D-1-500A-X
24-ROTARY DRYERS
8' DIA. x 80' LONG
200 H.P. DRIVE EACH

C-1-507
BELT CONVEYOR
24" WIDE x 400' LONG
10 H.P. DRIVE

T-1-548
1-CALCINER FEED BIN
1-CONE BOTTOMS WITH BIN FEEDER
1-HOUR STORAGE CAPACITY
14' WIDE x 14' DEEP x 14' LONG

D-1-501
1-ROTARY CALCINER
10' DIA. x 300' LONG
2-75 H.P. DRIVES

E-1-503
1-ROTARY COOLER
9'6" DIA. x 70' LONG
100 H.P. DRIVE

C-1-509
DRAG CONVEYOR
18" WIDE x 140' LONG
5-H.P. DRIVE

T-1-549 A-F
6-STORAGE SILOS
1-WEEK STORAGE CAPACITY
30' DIA x 75' HIGH, EACH

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE

SCALE	DATE	LOCATION OF JOB
DRAWN BY E.P.P.	6-12-53	
CHECKED BY		
CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
450 TON UNIT
SHEET 5 OF 5

APPN. NO.
DRWG. NO. F-1-504
FILE NO.

L-1-500 BUCKET ELEVATOR
C-1-507 BELT CONVEYOR
T-1-548 CALCINER FEED BIN
D-1-500 A-X 24- ROTARY DRYERS
E-1-500 A-F 6- EXCHANGERS
BC-1-500 A-B 2-BAROMETIC CONDENSERS
EV-1-500 A-F TRIPLE EFFECT EVAPORATORS 2-STRINGS
D-1-501 ROTARY CALCINER
T-1-547 DISTRIBUTOR STORAGE TANK
C-1-506 CONVEYOR BELT
SJ-1-E 20 A-B 2-STEAM JET REFRIGERATING UNIT
C-1-505 BELT CONVEYOR
T-1-524 A-M 13- PRECIPITATION TANKS
F-1-506 A-J
F-1-505 A-M
F-1-504 A-M
F-1-503 A-M
F-1-501 A-P
"A"
T-1-524 A
T-1-524 B
T-1-524 C
T-1-524 D
T-1-524 E
T-1-524 F
T-1-524 G
T-1-524 H
T-1-524 I
T-1-524 J
T-1-524 K
T-1-524 L
T-1-524 M
T-1-500 A
T-1-500 B
T-1-500 C
T-1-500 D
T-1-500 A-D 4- CRYSTALLIZERS TANKS
L-1-501 BUCKET ELEVATOR
C-1-509 DRAG CONVEYOR
E-1-509 ROTARY COOLER
FUEL OIL PUMPS
T-1-549 A
T-1-549 B
C-1-510 BELT CONVEYOR
T-1-549 C
CALCINED ALUMINA STORAGE SILOS
T-1-549 D
T-1-549 E
T-1-549 F
T-1-54G
FUEL OIL STORAGE
"B"
K-1-501
ELEV
PUMPS
C-1-503 13-SCREW CONVEYORS
F-1-502 A-J
F-1-500C
F-1-500B
F-1-500A
T-1-525 A
T-1-525 B
K-1-500
T-1-508 LIQUOR SETTLING TANK
OFFICE
ELEV
C-1-500 TO AMMONIA SULFATE DECOMPOSITION DWG-L-1-800
CR-1-501 A-T 20- CRYSTALLIZERS
CR-1-502 A-V 22-CRYSTALLIZERS
CR-1-500 A-L 4-STRINGS TRIPLE EFFECT EVAPORATORS CRYSTALLIZERS

PLAN VIEW

28

REFERENCE DRAWINGS
F-1-500 TO F-1-504 - FLOW DIAGRAMS
SHEETS 1 TO 5.

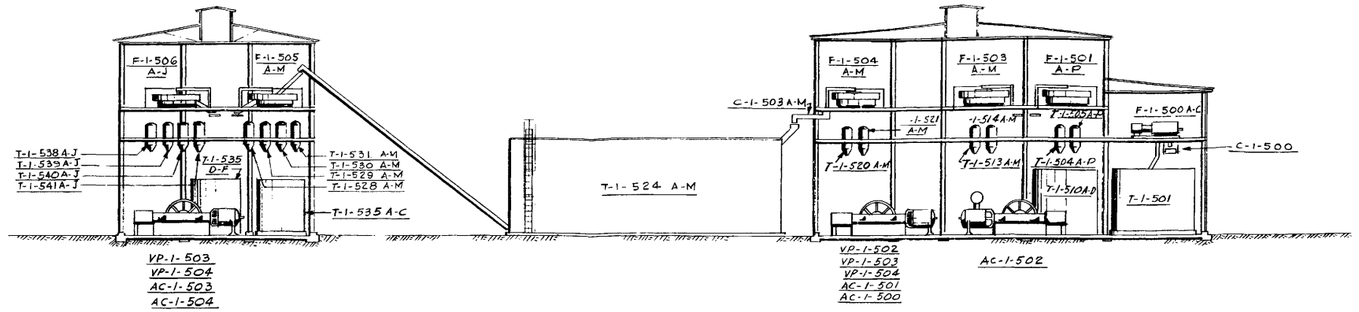
MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE

SCALE 0 10 30 50 FT
DRAWN BY H.D.R. DATE 5-28-53
CHECKED BY
CHECKED BY
LOCATION OF JOB

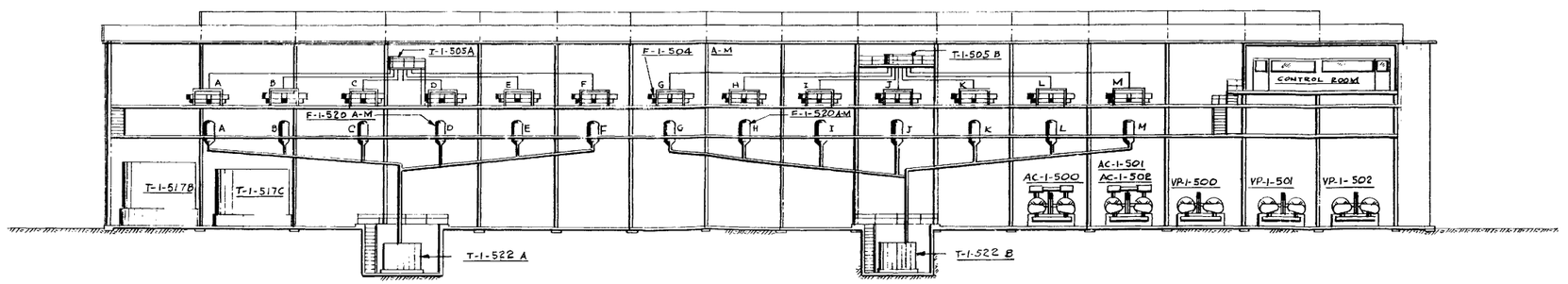
INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
LAYOUT
ALUMINA RECOVERY
450 TON UNIT

APPN. NO.
DRWG. NO. L-1-500
FILE NO.



SECTION "B-B"



SECTION "A-A"

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE 0 5 10 15 20 FT.	DATE	LOCATION OF JOB
L-1-500 LAYOUT											DRAWN BY H.D.R.		
											CHECKED BY		
											CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
SECTIONS
ALUMINA RECOVERY
450 TON UNIT

APPR. NO.
DRWG. NO. L-1-501
FILE NO.

AMMONIUM SULFATE REMOVAL

C-2-500
1-WEIGH CONVEYOR BELT
18" WIDE × 300' LONG
5 HP DRIVE

WET CAKE TO T-2-800, SHEET F-2-800
26.1 TONS/HR. AMMONIUM SULFATE
0.5 TONS/HR. LIQUOR

CENTRIFUGE FEED
89 TONS/HR. SLURRY
243 GPM SP. GR.-1.47

F-2-500A-B

F-2-500A-B
2-CONTINUOUS CENTRIFUGES
8'-6" DIA. × 10'-0" LONG, EACH
50 HP EACH

LIQUOR RECYCLE FROM CENTRIFUGE
62.4 TPH, LIQUOR
202 GPM SP.GR.-1.24

LIQUOR FROM SECOND ALUM FILTRATION FROM T-2-515, SHEET F-2-501
442.1 TONS/HR. LIQUOR
1486 GPM SP. GR.-1.20

T-2-501

CRYSTALLIZER FEED
504.5 TONS/HR., LIQUOR
1688 GPM
SP. GR.-1.20

P-2-508A-C

T-2-501
1-CRYSTALLIZER FEED TANK
15 MIN. SURGE TIME
30,000 GAL. CAPACITY
17'DIA. × 18' HIGH

P-2-508 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
1015 GPM., MAXIMUM
845 GPM., OPERATING
SP. GR.-1.20
35' HEAD, 20 HP. EACH

$(NH_4)_2SO_4$ RECYCLE STREAM
170.0 TONS/HR. SLURRY
463 GPM SP. GR.-1.47

CRYSTALLIZER PRODUCT
259 TONS/HR., SLURRY
706 GPM. SP.GR.-1.47

COOLING TOWER WATER
10,800 GPM. @ 85° F

EVAPORATION OF ACID FILTRATE

E-2-500 A-F
6-EXCHANGERS
5525 SQ.FT. EACH

EV-2-500 A-F
2-STRING-TRIPLE EFFECT EVAPORATORS. 26' DIA EACH 18'-6" DIAM.

TOTAL OVERHEAD
113.1 TONS/HR. WATER

EJECTOR STEAM
338 LBS/HR. @ 100 PSIG

BC-2-500A-B
2-BAROMETRIC CONDENSERS

STEAM
142,500 LBS/HR.
100 PSIG

189°F
338°F
200°F
160°F
110°F

E-2-500 A-B
EV-2-500 A-B
E-2-500 C-D
EV-2-500 C-D
E-1-500 E-F
EV-2-500 E-F

EVAPORATOR DISCHARGE
106.6 T.P.H. DISSOLVED SOLIDS
248.9 TPH WATER
1037 GPM
SP. GR.-1.37

CLARIFIED ACID FILTRATE FROM T-2-106, DWG. F-2-301
106.6 T.P.H., DISS. SOLIDS
362.0 TONS/HR. WATER
1490 GPM SP.GR.-1.26

FEED ANALYSIS
20.25 TPH H_2S
24.86 TPH N_2O_3
2.91 TPH Fe_2O_3
64.3 TPH SO_4
0.0324 TPH U_3O_8

P-2-500A-C

P-2-500A-C
3-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
22,500 GPM., MAXIMUM
18,750 GPM., OPERATING
SP.GR.-1.30
20'HEAD, 200 HP. EACH

P-2-501A-C

P-2-501A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
20,100 GPM., MAXIMUM
16,750 GPM., OPERATING
SP.GR.-1.34
20'HEAD, 200 HP. EACH

P-2-502 A-C

P-2-502A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
17,900 GPM., MAXIMUM
14,900 GPM., OPERATING
SP.GR.-1.37
20' HEAD, 175 H.P. EACH

CONDENSATE DISCHARGE
2814 TONS/HR, WATER
11,250 GPM.

P-2-503 A-C

P-2-503 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
6750 GPM., MAXIMUM
5625 GPM., OPERATING
SP.GR.-1.0
50' HEAD, 125 H.P. EACH

AMMONIUM SULFATE CRYSTALLIZATION

E-2-501A-F
6-EXCHANGERS
19,500 SQ.FT. EACH

FIRST EFFECT OVERHEAD
89.8 TONS/HR., WATER

SECOND EFFECT OVERHEAD
78.2 TONS/HR., WATER

THIRD EFFECT OVERHEAD
82.5 TONS/HR., WATER

CR-2-500A-F
2-STRINGS OF TRIPLE EFFECT EVAPORATOR CRYSTALLIZERS
EACH CRYSTALLIZING UNIT - 26'DIA.

COOLING TOWER WATER
24,650 G.P.M. @ 85°F

EJECTOR STEAM
740 LBS/HR
100 PSIG

BC-2-501A-B
2-BAROMETRIC CONDENSERS

STEAM
253,500 LBS/HR.
15-PSIG

195°F
153°F
110°F

CR-2-500A-B
CR-2-500C-D
CR-2-500E-F

212°F
167°F
122°F

E-2-501 A-B
E-2-501 C-D
E-2-501 E-F

P-2-509A-C
P-2-510A-C
P-2-509D-F
P-2-510D-F
P-2-509G-I
P-2-510G-I

P-2-511A-C

CONDENSATE DISCHARGE
6,405 TONS/HR., WATER
25,600 GPM.

P-2-509A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
8460 GPM., MAXIMUM
7030 GPM., OPERATING
SP.GR.-1.47
25'HEAD, 125HP EACH

P-2-510A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
141 GPM, MAX.
118 GPM, OPERATING
SP.GR.-1.20
125'HEAD, 10HP EACH

P-2-509D-F
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
8460 GPM., MAXIMUM
7030 GPM., OPERATING
SP.GR.-1.47
25'HEAD, 125HP EACH

P-2-510D-F
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
141 GPM, MAXIMUM
118 GPM, OPERATING
SP.GR.-1.20
125'HEAD, 10 HP. EACH

P-2-509 G-I
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
8460 GPM., MAXIMUM
7030 GPM., OPERATING
SP.GR.-1.47
25' HEAD, 125 HP. EACH

P-2-510 GI
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
141 GPM., MAXIMUM
118 GPM., OPERATING
SP.GR.-1.20
125' HEAD, 10 HP EACH

P-2-511 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
15,350 GPM., MAXIMUM
12,800 GPM., OPERATING
SP. GR.-1.00
50' TOTAL HEAD
250 HP. EACH

STEAM JET COOLING

EJECTOR STEAM
228 LBS/HR.
100 PSIG

COOLING TOWER WATER
12,250 GPM @ 85° F

WATER EVAPORATED
13.7 TONS/HR., WATER

SJ-2-500A-B
2-STEAM JET REFRIGERATING UNIT
1200 TONS OF REFRIGERATION

BOOSTER STEAM
30,500 LBS/HR.
100 PSIG

P-2-504 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
818 GPM, MAXIMUM
723 GPM, OPERATING
50' HEAD 25 HP. EACH
SP.GR.-1.42

130° F

SJ-2-500 A-B

P-2-504 A-C

P-2-505 A-C

HOT WELL DISCHARGE
3094 TONS/HR, WATER
12,350 GPM

P-2-505 A-C
3-CENTERIFUGAL PUMPS
2-OPERATING, 1-SPARE
7410 GPM., MAXIMUM
6175 GPM., OPERATING
SP.GR.-1.00
50' HEAD, 150 HP. EACH

FIRST ALUM CRYSTALLIZATION

E-2-502 A-D
4-COOLING COOLS
10,500 SQ. FT. AREA EACH
35,350,000 BTU/HR. TOTAL

CRYSTAL RECYCLE FROM T-2-508, SHEET F-2-501
5.4 TONS/HR., ALUM - 53 GPM
12.4 TONS/HR., LIQUOR
SP. GR. 1.36

DEEP WELL WATER
17,500 GPM. @ 120°F

FEED TO FILTERS F-2-501, SHEET F-2-501
529.6 TONS/HR. SLURRY
1498 GPM SP.GR.-1.42

77° F

T-2-500A
T-2-500B
T-2-500C
T-2-500D

E-2-502A
E-2-502B
E-2-502C
E-2-502D

R-2-500A
R-2-500B
R-2-500C
R-2-500D

FEED TO FIRST ALUM CRYSTALLIZERS
511.8 TONS/HR SLURRY
1445 GPM SP.GR.-1.42

P-2-506A-B
P-2-506C-D
P-2-506E-F
P-2-507A-B

T-2-500A-D
4-CRYSTALLIZERS
5 HRS. RETENTION TIME TOTAL
125,000 GAL CAPACITY EACH
40' DIA., x 13', 2:0 CONE

R-2-500A-D
4-RAKE MECHANISMS
7.5 HP EACH

P-2-506A-F
6-CENTRIFUGAL PUMPS
3-OPERATING, 3-SPARE
1735 GPM, MAX.
1445 GPM, OPERATING
SP.GR.-1.42
30'HEAD, 30 HP EACH

P-2-507A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1860 GPM, MAX.
1498 GPM, OPERATING
SP.GR.-1.40
50'HEAD, 50 HP EACH

REFERENCE DRAWINGS		MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE	DATE	LOCATION OF JOB
F-2-501	PROCESS FLOW DIAGRAM No.2											DRAWN BY H.L.K.-L.W.C.	6-6-62	
F-2-502	" " " No.3											CHECKED BY		
F-2-503	" " " No.4											CHECKED BY		
F-2-504	" " " No.5													

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS NEW JERSEY, FLORIDA
DIVISION RESEARCH

TITLE: PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
225 TON UNIT
SHEET 1 OF 5

APPN. NO.
DRWG. NO. F-2-501
FILE NO.

FIRST ALUM FILTRATION — FIRST REDISSOLVING OF ALUM — SECOND ALUM CRYSTALLIZATION — SECOND ALUM FILTRATION

$(NH_4)_2SO_4$ WASH TO T-2-501, DWG. F-2-500
442.1 TONS/HR., LIQUOR
1486 GPM. SP. GR. -1.20

CRYSTALLIZER FEED
FROM T-2-500, DWG. F-2-500
523.6 TONS/HR. SLURRY
1498 GPM - SP.GR. 1.42

X-2-500
SLURRY DISTRIBUTOR
2-MIN. RESIDENCE TIME
3500 GAL. CAPACITY
9'-0" DIA. x 8' HIGH

X-2-501
WASH LIQUOR DISTRIBUTOR
2-MIN. RETENTION TIME
1800 GAL. CAPACITY
7'-0" DIA. x 6' HIGH

FILTRATE FROM THIRD ALUM FILTRATION
272.9 TONS/HR. 325 GPM. SP.GR.-1.18

77°F

81°F

WASH LIQUOR TO 1ST ALUM FILTRATION
222.5 TONS/HR. LIQUOR
740 GPM SP.GR. 1.20

FILTER FEED
706.1 TONS/HR., SLURRY
2140 GPM. SP.GR.-1.32

X-2-502
SLURRY DISTRIBUTOR
2-MIN. RETENTION TIME
3,150 GAL. CAPACITY
10' DIA. x 9' HIGH

X-2-503
WASH LIQUOR DISTRIBUTOR
2-MIN. RETENTION TIME
1800 GAL. CAPACITY
7' DIA. 6' HIGH

X-2-500 X-2-501 X-2-502 X-2-503

WASH LIQUOR TO 2ND ALUM FILTRATION
224.5 TONS/HR. LIQUOR
760 G.P.M. 1.182 SP.GR.

FILTER CAKE TO T-2-517 DWG F-2-502
38.4 TONS/HR. LIQUOR
223.6 TONS/HR. ALUM

C-2-501
1-BELT CONVEYORS
24" x 200' LONG
5 H.P. DRIVE EACH

F-2-501 A-H
8-HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE-1.5 H.P.

FILTER CAKE
38.2 TONS/HR. LIQUOR
223.8 TONS/HR. ALUM

C-R-2-501 A-J
10-VACUUM CRYSTALLIZERS
EACH UNIT 26' DIA

SJ-2-501 A-J
10-STEAM JET REFRIGERATING UNITS
860 TONS OF REFRIGERATION, EACH

F-2-503 A-G
7-HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE-1.5 H.P.

T-2-502
COMPRESSED AIR RECEIVER
4' DIA. x 17' HIGH

T-2-503
VACUUM SCRUBBER
7'-6" DIA. x 15' HIGH

T-2-510 A-D
4-ALUM REDISSOLVING TANKS
30 MIN. RETENTION TIME
25,000 GAL. CAPACITY
16' DIA. x 17' HIGH

A-2-510 A-H
8-SIDE ENTERING AGITATORS
15 H.P. DRIVE EACH

HEATING STEAM
62,500 LBS/HR
@ 100 PSIG

COOLING TOWER WATER
46,250 GPM @ 85°F

C-2-502
1-BELT CONVEYOR
24" WIDE x 200' LONG
5 H.P. DRIVE

T-2-510A T-2-510B T-2-510C T-2-510D
A-B C-D E-F G-H
E-2-503A E-2-503B E-2-503C E-2-503D

EVAPORATED WATER
53.3 TONS/HR. WATER

BOOSTER STEAM
197, 500 LBS/HR @
100 PSIG

160°F

FEED TO POLISHING FILTER
759.4 TONS/HR. LIQUOR
2353 GPM. SP.GR. - 1.27

E-2-503 A-D
4-STEAM COILS
3100 SQ.FT. AREA EACH
67,150,000 BTU/HR. TOTAL

T-2-511 T-2-512 T-2-513 A-G T-2-514 A-G

T-2-513 A-G
7-FILTRATE RECEIVERS
1-MIN. RETENTION TIME
275 GAL. CAP. EACH
3' DIA. x 5'-6"

T-2-514 A-G
7-WASH RECEIVERS
1-MIN. RETENTION TIME
140 GAL. CAP. EACH
2' DIA. x 6'

T-2-502 A-H
8-FILTRATE RECEIVERS
1-MIN. RESIDENCE TIME
117 GAL. CAP. EACH
2'-0" DIA. x 5'-0"

T-2-505 A-H
8-WASH RECEIVERS
1-MIN. RETENTION TIME EA.
117 GAL. CAPACITY EACH
2'-0" DIA. x 5'-0"

WASH LIQUOR FILTRATE
222.5 TONS/HR. LIQUOR
740 GPM
SP. GR. 1.20

X-2-515
1-LIQUOR DISTRIBUTOR
1-MIN. RESIDENCE TIME
2825 GAL. CAPACITY
8' DIA. x 8' HIGH

SJ-2-501 A-J

EJECTOR STEAM
1295 LBS/HR.
100 PSIG

T-2 511
COMPRESSED AIR RECEIVER
4" DIA. x 17'

T-2-512
VACUUM SCRUBBERS
7'-6" x 15' HIGH

FILTRATE -
5.4 TONS/HR. ALUM CRYSTALS
262.2 TONS/HR. LIQUOR, 861 GPM, SP.GR. 1.27

P-2-515 A-E P-2-515 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2825 GPM MAXIMUM
2353 GPM OPERATING
SP.GR. 1.27 - 150 H.P. EACH
125' TOTAL HEAD

CR-2-501 A-J
81°F

160°F

X-2-515

T-2-507
1-WASH LIQUOR SURGE TANKS
5-MIN. RETENTION TIME
5000 GAL. CAPACITY
8' x 8' x 10' DEEP

T-2-506 T-2-507

T-2-506
FILTRATE SURGE TANK
5-MIN. RESIDENCE TIME
5000 GAL. CAP.
8' x 8' x 10' DEEP

F-2-502 A-C F-2-502 D-F

P-2-517 A-K
11-CENTRIFUGAL PUMPS
10-OPERATING, 1-SPARE
9700 GPM, MAXIMUM
7580 GPM, OPERATING
SP.GR.-1.32
25' HEAD 100 HP EA.

AC-2-501
AIR COMPRESSOR
3000 CFM
375 H.P.

V.P.-2-501
1-VACUUM PUMPS
20,000 CFM
750 HP.

FILTRATE
442.1 TONS/HR, LIQUOR
1486 GPM. SP.GR.-1.20

T-2-515 T-2-516

WASH LIQUOR
224.5 TONS/HR. LIQUOR
760 GPM - SP.GR. 1.182

T-2-515
1-FILTRATE SURGE TANK
5-MIN. RETENTION TIME
9000 GAL. CAP. EACH
10' x 10' x 12' DEEP

T-2-516
1-WASH LIQUOR SURGE TANK
5-MIN. RETENTION TIME
4500 GAL. CAP. EACH
8' x 8' x 10' DEEP

AC-2-500
AIR COMPRESSOR
3000 CFM
375 H.P.

VP-2-500
1-VACUUM PUMP
20,000 CFM,
750 HP.

FEED TO URANIUM RECOVERY
T-2-602, DWG T-2-600
249.8 TONS/HR. LIQUOR
788 GPM. SP.GR.-1.27

COMPOSITION

SO_4 -	81.2%	TONS/HR.
NH_3 -	15.55	TONS/HR.
P_2O_5 -	20.25	TONS/HR.
Al_2O_3 -	1.24	TONS/HR.
Fe_2O_3 -	2.91	TONS/HR
U_3O_8 -	0.032%	TONS/HR.

P-2-512 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1010 GPM, MAX.
840 GPM, OPERATING
SP.GR.-1.27
50' HEAD 25 HP EACH

P-2-513 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
885 G.P.M. MAXIMUM
740 G.P.M. OPERATING
SP.GR. 1.20 - 20 H.P. EA.
50' TOTAL HEAD

F-2-502 A-F
6-POLISHING FILTERS
3-OPERATING, 3-OFF-STREAM
1304 SQ. FT. EACH

P-2-520 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1785 GPM MAXIMUM
1486 GPM OPERATING
SP.GR. 1.20 50 H.P. EACH
50' TOTAL HEAD

P-2-521 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
915 GPM MAXIMUM
760 GPM OPERATING
SP.GR. 1.18 - 20 H.P. EACH
50' TOTAL HEAD

HOT WELL DISCHARGE
11,700 TONS/HR., WATER
46,850 GPM @ 99°F

T-2-508
FILTRATE SURGE & SETTLING TANK.
5 HR. RESIDENCE TIME
250,000 GAL. CAPACITY
40' DIA. x 27' HIGH

T-2-509
FILTRATE SURGE TANK
5-MIN. RETENTION TIME
14,000 GAL. CAP.
14' DIA. x 13' HIGH

T-2-508 R-2-508 T-2-509

R-2-508
SETTLING RAKE
15 HP. DRIVE

P-2-542 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
945 GPM, MAXIMUM
788 GPM, OPERATING
SP. GR- 1.27
100' HEAD - 50 HP EACH.

P-2-514 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
63 GPM, MAXIMUM
53 GPM, OPERATING
SP. GE.-1.36
50' HEAD 3 HP EACH

P-2-516
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2825 GPM. MAXIMUM
2353 GPM OPERATING
SP.GR. 1.27 - 60 H.P. EACH
50' TOTAL HEAD

P-2-518 A-K
11-CENTRIFUGAL PUMPS
10-OPERATING, 1-SPARE
860 GPM, MAXIMUM
212 GPM, OPERATING
SP. GR. -1.32
50' HEAD 10 HP EACH

P-2-519 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
28,125 GPM MAXIMUM
23,450 GPM, OPERATING
SP. GR.-1.0
50' HEAD 450 H.P. EACH

FEED TO ALUM CRYSTALLIZERS
759.4 TONS/HR. LIQUOR
2353 GPM. SP.GR.-1.29

CRYSTAL RECYCLE TO T-2-500, DWG F-2-500
5.4 TONS/HR., ALUM CRYSTALS - 53 GPM
12.4 TONS/HR., LIQUOR SP.GR.- 1.36

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REFERENCE DRAWINGS			MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY
F-2-500	PROCESS FLOW - SHEET #1										
F-2-502	"	" - " #3									
F-2-503	"	" - " #4									
F-2-504	"	" - " #5									

DATE	SCALE	DATE	LOCATION OF JOB
	DRAWN BY H.D.R-EAD	5/18/53	
	CHECKED BY		
	CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
225 TON UNIT
SHEET NO 2 OF 5

APPN. NO.
DRWG. NO. F-2-501
FILE NO.

SECOND REDISSOLVING OF ALUM — THIRD ALUM CRYSTALLIZATION — THIRD ALUM FILTRATION — $Al(OH)_3$ PRECIPITATION — NH_4OH MAKE-UP

LIQUOR FROM THIRD ALUM FILTRATION TO F-2-503
SHEET F-2-501
497.4 TONS/HR., LIQUOR 1695 GPM SP GR. - 1.13

212°F

23.5 WT. % $(NH_4)_2SO_4$ SOLUTION
248.0 TONS/HR. WATER
76.6 TONS/HR. $(NH_4)_2SO_4$
1161 GPM SP GR. 1.14

FILTER CAKE FROM C-2-502, SHEET F-2-501
225.6 TONS/HR., ALUM
38.4 TONS/HR., LIQUOR

81°F

T-2-517 A-D
4-ALUM RESOLUTION TANKS
30 MIN. RETENTION TIME
23,000 GAL. CAPACITY EACH
16' DIA. x 15' HIGH

E-2-504 A-D
4-STEAM COILS
828 SQ. FT. AREA EACH
17,900,000 BTU/HR.

X-2-504
1-DISTRIBUTOR
2-MIN. RETENTION TIME
6250 GAL. CAPACITY
11-0" DIA. x 3' HIGH

A-2-517 A-H
8-SIDE ENTERING AGITATORS
15-HP. DRIVE, EACH

FEED TO ALUM CRYSTALLIZATION
804 TONS/HR., LIQUOR
2553 GPM. SP.GR- 1.26

P-2-522 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
3060 GPM MAXIMUM
2338 GPM OPERATING
SP GR 1.26 65'-MAXIMUM
40' HEAD

P-2-523 A-L
12-CENTRIFUGAL PUMPS
11-OPERATING, 1-SPARE
9600 GPM MAXIMUM
8000 GPM OPERATING
SP.GR. 1.26 125 H.P. EACH
25' HEAD

WASH FROM 3RD ALUM FILTRATION
159.6 TONS/HR. WATER
49.2 TONS/HR. $(NH_4)_2SO_4$
6.6 TONS/HR. ALUM
713 GPM SP GR 1.141

STEAM
18,100 LBS/HR @ 100 PSIG

COOLING TOWER WATER
47,300 GPM. @ 85°F

WATER EVAPORATED
54.4 TONS/HR, WATER

BOOSTER STEAM
202,500 LBS/HR. @ 100 PSIG

EJECTOR STEAM
1325 LBS/HR. @ 100 PSIG

CR-2-502 A-K

X-2-504

81°F

P-2-524 A-B
12-CENTRIFUGAL PUMPS
11-OPERATING, 1-SPARE
255 GPM., MAXIMUM
212 GPM. OPERATING
SP.GR. 1.28 10 HP EACH
50' HEAD

P-2-525 A-D
4-CENTRIFUGAL PUMPS
3-OPERATING, 1-SPARE
19,200 GPM, MAXIMUM
15,980 GPM, OPERATING
SP.GR - 1.0
50' HEAD 350 HP EACH

HOT WELL DISCHARGE
12,975 TONS/HR., WATER
47,920 GPM. @ 99°F

FILTER FEED
749.4 TONS/HR., SLURRY
2335 GPM SP.GR.- 1.28

5J-2-502 A-K
11-STEAM JET REFRIGERATING UNITS
800 TONS OF REFRIGERATION EACH

CR-2-502 A-K
11-VACUUM CRYSTALLIZERS
EACH CRYSTALLIZING UNIT- 26' DIA.

X-2-505
SLURRY DISTRIBUTOR
2-MIN. RETENTION TIME
5600 GAL. CAPACITY
11' DIA. x 8' HIGH

E-2-504 A-G
7-HORIZONTAL FILTERS
15' DIA. EACH
3-HP. DRIVE EACH
SCROLL DISCHARGE-1.5 HP.

AC-2-502
1-AIR COMPRESSOR
3,000 CFM.
375 HP.

VP-2-502
1-VACUUM PUMP
20,000 CFM
750 HP.

P-2-526 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2010 GPM MAXIMUM
1685 GPM OPERATING
SP.GR. 1.18 50 H.P. EACH
50' HEAD

T-2-522
FILTRATE SURGE TANK
5-MIN. RETENTION TIME
10,000 GAL. CAP. EACH
11' x 11' x 11' DEEP

P-2-527 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
865 GPM MAXIMUM
719 GPM OPERATING
SP.GR.-1.14 20 H.P. EACH
50 TOTAL HEAD

T-2-523
WASH LIQUOR SURGE TANK
5 MIN. RETENTION TIME
4300 GAL. CAPACITY
8' x 8' x 9' DEEP

X-2-506
WASH LIQUOR DISTRIBUTORS
2-MIN. RETENTION TIME
1725 GAL. CAPACITY
7' DIA. x 6' HIGH

AMMONIUM SULFATE SOLUTION @ 81°F
FROM K-2-501, SHEET F-2-503
59.6 TONS/HR, WATER 719 GPM
49.2 TONS/HR. $(NH_4)_2SO_4$ SP.GR.- 1.14

AMMONIUM SULFATE SOLUTION @ 212°F
FROM K-2-501, SHEET F-2-503
248.0 TONS/HR., WATER 1161 GPM
76.6 TONS/HR., $(NH_4)_2SO_4$ SP.GR.- 1.14

FILTER CAKE
208.8 TONS/HR. ALUM CRYSTALS
1.2 TONS/HR. ALUM IN SOLUTION
8.6 TONS/HR. $(NH_4)_2SO_4$ IN SOLUTION
26.8 TONS/HR. WATER

C-2-503 A-G
7-SCREW CONVEYORS
24" DIA. x 20' LONG
7500 CU. FT./HR. SOLIDS
10 HP DRIVE 55 PPM

25% NH_3 FEED
47.2 TONS/HR. NH_3
141.6 TONS/HR. WATER
830 GPM
SP.GR. 0.91

FEED TO F-2-505, SHEET F-2-503
23.6 TONS/HR. NH_3
131.1 TONS/HR. $(NH_4)_2SO_4$
36.1 TONS/HR. $Al(OH)_3$
243.4 TONS/HR WATER
1435 GPM SP.GR 1.21

T-2-524 A-G
7-PRECIPITATION TANKS
12' WIDE x 85' LONG x 30' DEEP
3-HOURS RETENTION TIME
8-HORIZ. APRON CONVEYORS (FLIGHTS ATTACHED) PER TANK
1-INCLINED APRON CONVEYOR (FLIGHTS ATTACHED) PER TANK
12' WIDE x 80' LONG - 6" FLIGHTS EACH

P-2-528 A-H
8-CENTRIFUGAL PUMPS
7-OPERATING, 1-SPARE
240 GPM, MAXIMUM
200 GPM, OPERATING
SP.GR.- 1.00 5 HP, EACH
50' HEAD

WASH AMMONIUM SOLUTION FROM T3-8 SHEET F-3-801
20.7 TONS/HR. NH_3 663 GPM
141.6 TONS/HR. WATER. - SP.GR. 0.981

K-2-500

T-2-518

T-2-519
VACUUM SCRUBBER
7'-6" DIA. x 15' HIGH

T-2-520 A-G
7-FILTRATE RECEIVERS
1-MIN. RETENTION TIME EACH
315-GAL. CAPACITY EACH
3' DIA. x 6' HIGH

T-2-521 A-G
7-WASH LIQUOR RECEIVERS
1-MIN. RETENTION TIME EACH
132-GAL. CAPACITY EACH
2' DIA. x 6' HIGH

T-2-518
COMPRESSED AIR SURGE TANK
4'-0" DIA. x 17 HIGH

T-2-522

T-2-523

FILTRATE
497.4 TONS/HR., LIQUOR
SP.GR.- 1.18 -1685 GPM

NH_3 MAKE-UP
2.3 TONS/HR. NH_3
12 GPM
SP.GR. 0.597

T-2-525

P-2-526 A-B

P-2-527 A-B

P-2-529
1-CENTRIFUGAL PUMP
500 GPM. OPERATING
SP.GR.- 0.597
100' HEAD 15 HP.

T-2-525
LIQUID NH_3 STORAGE TANK
8 HR. TOTAL CAPACITY
7000 GAL. CAPACITY
6'-6" DIA. x 26' HIGH

P-2-530 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1000 GPM MAXIMUM
830 GPM, OPERATING
SP.GR.- 0.9 15 HP. EACH
50' HEAD

K-2-500
AMMONIA ABSORPTION COLUMN
9'-6" DIA. x 50' HIGH

AMMONIA FROM K-2-501, SHEET F-2-503
23.6 TONS/HR., NH_3

WASH LIQUOR FROM 3 RD ALUM FILTER
159.6 TONS/HR. WATER
49.2 TONS/HR. $(NH_4)_2SO_4$
6.6 TONS/HR. ALUM
713 GPM
SP.GR. 1.141

32

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE
F-2-500 - PROCESS FLOW - SHEET No 1										
F-2-501 - " " " No 2										
F-2-503 - " " " No 4										
F-2-504 - " " " No 5										

SCALE	DATE	LOCATION OF JOB
DRAWN BY H. C. K. E.P.P.	5/15/59	
CHECKED BY		
CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE: PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
225 TON UNIT
SHEET-3 OF 5

APPN. NO.
DRWG. NO. F-2-502
FILE NO.

~ FIRST $AL(OH)_3$ FILTRATION ~

~ $AL(OH)_3$ REPULPING ~

~ SECOND $AL(OH)_3$ FILTRATION ~

~ AMMONIA RECOVERY ~

FEED FROM T-2-524, DWG F-2-502
434.2 TONS/HR. SLURRY, 1435 GPM
SP.GR. - 1.21

COMPOSITION
FREE NH_3 - 23.6 TONS/HR.
$(NH_4)_2SO_4$ - 131.1 TONS/HR.
$AL(OH)_3$ - 36.1 TONS/HR.
WATER - 243.4 TONS/HR.

X-2-507
1-SLURRY DISTRIBUTOR
2-MIN. RESIDENCE TIME
3450 GAL. CAPACITY
9' DIAM. x 7'

X-2-508
1-WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
2800 GAL. CAPACITY
9' DIAM. x 6'

X-2-509
1-WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
2800 GAL. CAPACITY
9' DIAM. x 6'

X-2-510
1-FILTRATE WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
2800 GAL. CAPACITY
9' DIAM. x 6'

WASH LIQUOR
299.6 TONS/HR. LIQUOR
5.6 TONS/HR. NH_3 1153 GPM
13.4 TONS/HR. SO_4 SP.GR. - 1.04

RESOLUTION LIQUOR
304.4 TONS/HR., LIQUOR
2.8 TONS/HR., NH_3 1200 GPM
6.7 TONS/HR., SO_4 SP.GR. - 1.02

F-2-505A-G
7 - HORIZONTAL FILTERS
15' DIAM. EACH
3 HP DRIVE EACH
1.5 HP SCROLL DISCHARGE

T-2-526
1-COMPRESSED AIR SURGE TANK
4' DIAM. x 17'

C-2-504
1-CONVEYOR BELT
24" x 200' LONG
5 HP

FILTER CAKE
176.8 TONS/HR. TOTAL WET CAKE
6.8 TONS/HR. NH_3
17.4 TONS/HR. SO_4

T-2-535A — **A-2-535A-B**
T-2-535B — **A-2-535C-D**
T-2-535C — **A-2-535E-F**

T-2-527
1-VACUUM SCRUBBER
7'-6" DIA. x 15'

T-2-528 A-G
T-2-529 A-G
T-2-530 A-G
T-2-531 A-G

T-2-528A-G
7-FILTRATE RECEIVERS
1-MIN. RESIDENCE TIME
170 GAL. CAPACITY
2'-6" DIAM. x 5'

T-2-529A-G
7 - WASH RECEIVERS
1-MIN. RESIDENCE TIME
215 GAL. CAPACITY
2'-6" DIAM. x 6'

T-2-530A-G
7 - WASH RECEIVERS
1-MIN. RESIDENCE TIME
215 GAL. CAPACITY
2'-6" DIAM. x 6'

T-2-531A-G
7 WASH RECEIVERS
1-MIN. RESIDENCE TIME
215 GAL. CAPACITY
2'-6" DIAM. x 6'

T-2-535A-C
3-REPULPING TANKS
5 MIN. RETENTION TIME TOTAL
10650 GAL. CAP. EACH
12' DIAM. x 13'

A-2-535A-F
6-SIDE ENTERING AGITATORS
7.5 HP EACH

FILTRATE
252.8 TONS/HR. LIQUOR
45.0 TONS/HR. NH_3 922 GPM
64.6 TONS/HR. SO_4 SP.GR. - 1.09

FINAL WASH SOLUTION
304.2 TONS/HR. LIQUOR
11.0 TONS/HR. NH_3 1140 GPM
26.6 TONS/HR. SO_4 SP.GR. - 1.07

NO. 2 WASH
NO. 1 WASH

T-2-532
1-FILTRATE SURGE TANK
5 MIN. RESIDENCE TIME
12,200 GAL. CAPACITY
11' x 11' x 14' DEEP

T-2-533
1-WASH SURGE TANK
2 MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-2-534
1-WASH SURGE TANK
2 MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

AC-2-503
1-AIR COMPRESSOR
3000 CFM
375 HP

VP-2-503
1-VACUUM PUMP
20,000 CFM
750 HP

P-2-531 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2440 GPM, MAX.
2062 GPM, OPERATING
SP.GR. - 1.09
50' HEAD, 50 HP EACH

P-2-532A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1390 GPM, MAX.
1160 GPM, OPERATING
SP.GR. - 1.06
50' HEAD, 30HP EACH

P-2-533 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1390 GPM, MAX.
1160 GPM, OPERATING
SP.GR. - 1.04
50' HEAD, 30 HP EACH

FILTRATE
557 TONS/HR. LIQUOR
125.8 TONS/HR. $(NH_4)_2SO_4$
23.6 TONS/HR. NH_3 2062 GPM
407.6 TONS/HR. WATER SP.GR. - 1.09

P-2-534A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2130 GPM, MAX.
1774 GPM, OPERATING
SP.GR. - 1.09
50' HEAD, 40 HP EACH

T-2-542
1-FILTRATE SURGE TANK
5-MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-2-543
1 - WASH SURGE TANK
5-MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-2-544
1 - WASH SURGE TANK
5-MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

T-2-545
1 - WASH SURGE TANK
5-MIN. RESIDENCE TIME
7000 GAL. CAPACITY
10' x 10' x 10' DEEP

P-2-535A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1385 GPM, MAX.
1153 GPM, OPERATING
SP.GR. - 1.04
50' HEAD, 30 HP EACH

P-2-536A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1440 GPM, MAX.
1200 GPM, OPERATING
SP.GR. - 1.02
50' HEAD, 30HP EACH

P-2-537A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1430 GPM, MAX
1190 GPM, OPERATING
SP.GR. - 1.01
50' HEAD, 30 HP EACH

P-2-538A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1420 GPM, MAX
1180 GPM, OPERATING
SP.GR. - 1.0
50' HEAD, 30HP EACH

FILTER FEED
481.2 TONS/HR. TOTAL SLURRY
9.2 TONS/HR. NH_3 1774 GPM
24.2 TONS/HR. SO_4 SP.GR. - 1.09

X-2-511
1-SLURRY DISTRIBUTOR
2-MIN. RESIDENCE TIME
4250 GAL. CAPACITY
9' DIAM. x 9'

X-2-512
1-WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
2850 GAL. CAPACITY
8' DIAM. x 8'

X-2-513
1-WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
2850 GAL. CAPACITY
8' DIAM. x 8'

X-2-514
1-WATER WASH DISTRIBUTOR
2-MIN. RESIDENCE TIME
2850 GAL. CAPACITY
8' DIAM. x 8'

WATER WASH
295 TONS/HR., WATER
1180 GPM

F-2-506A-E
5 - HORIZONTAL FILTERS
15' DIAM. EACH
3 HP DRIVE EACH
1.5 HP SCROLL DISCHARGE

T-2-539A-E
5 - WASH RECEIVERS
1-MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

T-2-536
1-COMPRESSED AIR SURGE TANK
4' DIAM. x 17'

T-2-537
1-VACUUM SCRUBBER
7'-6" DIA. x 15'

T-2-538 A-E
T-2-539 A-E
T-2-540 A-E
T-2-541 A-E

T-2-538A-E
5-FILTRATE RECEIVERS
1-MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

T-2-540A-E
5-WASH RECEIVERS
1-MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

T-2-541A-E
5-WASH RECEIVERS
1-MIN. RESIDENCE TIME
285 GAL. CAPACITY
3' DIAM. x 6'

FILTRATE
299.6 TONS/HR. TOTAL LIQUOR
5.6 TONS/HR. NH_3 1153 GPM
13.4 TONS/HR. SO_4 SP.GR. - 1.04

T-2-542 — **T-2-543** — **T-2-544** — **T-2-545**

NO. 3 WASH
NO. 2 WASH
NO. 1 WASH

AC-2-504
1-AIR COMPRESSOR
2000 CFM.
250 HP

VP-2-504
1-VACUUM PUMP
15,000 CFM
560 HP

P-2-534A-B
P-2-535A-B
P-2-536A-B
P-2-537A-B
P-2-538A-B

FINAL WASH SOLUTION
304.4 TONS/HR. LIQUOR
2.8 TONS/HR. NH_3 1200 GPM
6.7 TONS/HR. SO_4 SP.GR. - 1.02

C-2-505
1-CONVEYOR BELT
24" x 200' LONG
5 HP

WET CAKE TO T-2-547, DWG. F-2-504
172.2 TONS/HR. TOTAL WET CAKE
COMPOSITION
AL_2O_3 - 23.6 TONS/HR.
SO_4 - 4.0 TONS/HR.
NH_3 - 1.3 TONS/HR.
H_2O - 130.8 TONS/HR.

STRIPPER FEED
557 TONS/HR. TOTAL LIQUOR
125.8 TONS/HR. $(NH_4)_2SO_4$
23.6 TONS/HR. NH_3 2062 GPM
407.6 TONS/HR. WATER SP.GR. - 1.09

DEEP WELL WATER
1500 GPM @ 72°F

72°F
105°F

E-2-505
1-HEAT EXCHANGER
5000 SQ. FT.

AMMONIA TO K-2-500, DWG. F-2-502
23.6 TONS/HR. NH_3

K-2-501
1-AMMONIA STRIPPING COLUMN
5' DIAM. x 50'

E-2-506
1-HEAT EXCHANGER
6150 SQ. FT.

STEAM
145,000 LBS./HR.
@ 15 PSIG

DEEPWELL WATER
2600 GPM @ 72°F

E-2-507
1-HEAT EXCHANGER
6600 SQ. FT.

212°F
81°F

P-2-539A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
2255 GPM, MAX.
1880 GPM, OPERATING
SP.GR. - 1.14
100' HEAD, 75 HP EACH

P-2-539A-B

E-2-507

AMMONIUM SULFATE SOLUTION TO X-2-506, DWG. F-2-502
159.6 TONS/HR. WATER
49.2 TONS/HR. $(NH_4)_2SO_4$
719 GPM SP.GR. - 1.14

212°F

AMMONIUM SULFATE SOLUTION TO T-2-517, DWG. F-2-502
248 TONS/HR. WATER 1161 GPM
76.6 TONS/HR $(NH_4)_2SO_4$ SP.GR. - 1.14

REFERENCE DRAWINGS	
F-2-500, PROCESS FLOW DIAG	SHEET 1
F-2-501, " " "	" 2
F-2-502, " " "	" 3
F-2-504, " " "	" 5

MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE

SCALE
DRAWN BY L.I.V. 6-16-5.
CHECKED BY
CHECKED BY

LOCATION OF JOB

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

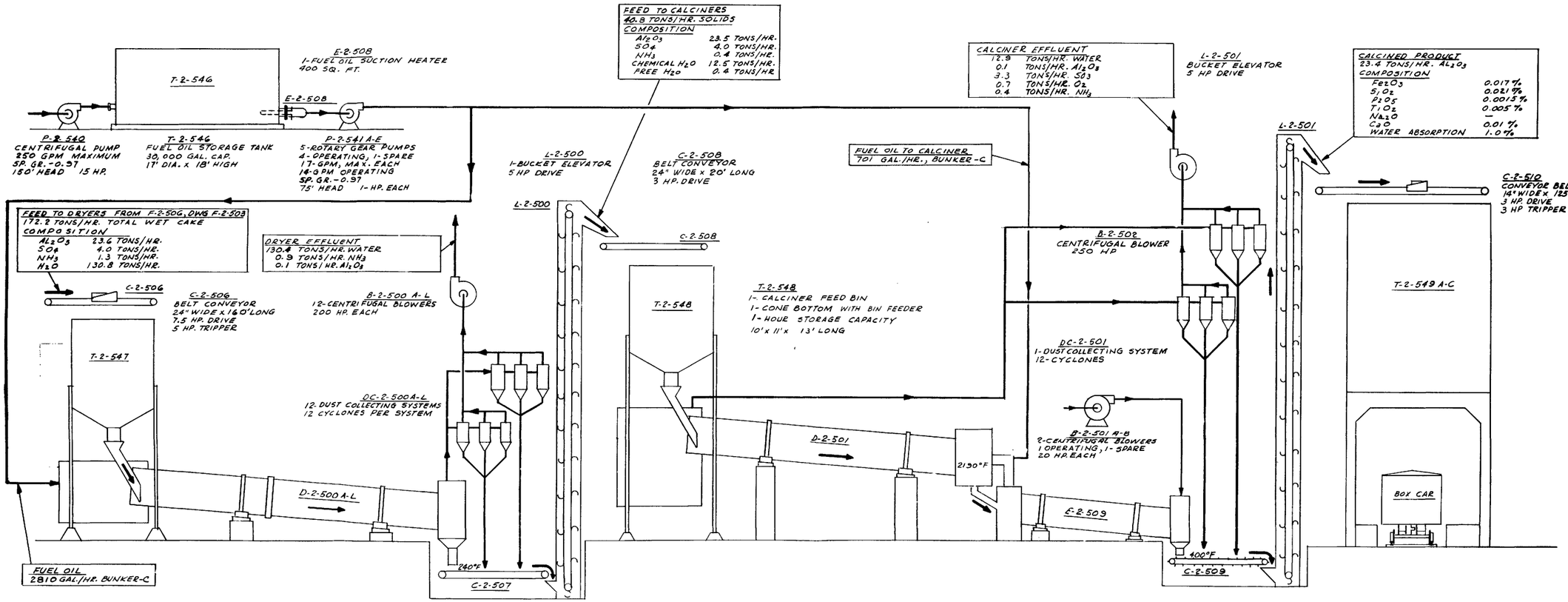
TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
225 TON UNIT
SHEET 4 OF 5

APPN. NO.
DRWG. NO. F-2-503
FILE NO.

DRYING

CALCINING & COOLING

STORAGE & SHIPPING



T-2-547
DRYER FEED BIN
12-CONE BOTTOMS WITH BIN FEEDERS
8-HOUR STORAGE CAPACITY
15' x 20' DEEP x 180' LONG

D-2-500 A-L
12-ROTARY DRYERS
8' DIA. x 80' LONG
200 HP. DRIVE EACH

C-2-507
BELT CONVEYOR
20" WIDE x 400' LONG
5 H.P. DRIVE

D-2-501
1-ROTARY CALCINER
8'-6" DIA. x 250' LONG
2-40 HP. DRIVES

E-2-509
1-ROTARY COOLER
8'-6" DIA. x 50' LONG
50 H.P. DRIVE

C-2-509
DRAG CONVEYOR
14" WIDE x 140' LONG
3 HP. DRIVE

T-2-549 A-C
3-STORAGE SILOS
1-WEEK TOTAL CAPACITY
30' DIA. x 75' HIGH, EACH

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE

SCALE	DATE	LOCATION OF JOB
DRAWN BY H.D.R	6-12-53	
CHECKED BY		
CHECKED BY		

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
225 TON UNIT
SHEET 5 OF 5

APPR. NO.
DRWG. NO. F-2-504
FILE NO.

L-2-500 BUCKET ELEVATOR

C-2-507 BELT CONVEYOR

T-2-548 CALCINER FEED BIN

D-2-500 A-L 12-ROTARY DRYERS

A B C D E F G H I J K L

T-2-547 DISTRIBUTOR STORAGE TANK

C-2-506 BELT CONVEYOR

E-2-500 A-F 6-EXCHANGERS

"A" "B" "C" "D" "E" "F"

PUMPS

EV-2-500 A-F 2-STRINGS TRIPLE EFFECT EVAPORATORS

"A"

"B"

SJ-2-500 A-B 2-STEAM-JET REFRIGERATING UNITS

D-2-501 ROTARY CALCINER

L-2-501 BUCKET ELEVATOR

C-2-509 DRAG CONVEYOR

E-2-509 ROTARY COOLER

C-2-505 BELT CONVEYORS

T-2-549A

C-2-510 BELT CONVEYOR

T-2-549B

CALCINED ALUMINA STORAGE SILOS

T-2-549C

T-2-546

FUEL OIL STORAGE

"B"

F-2-506 A-E

F-2-505 A-G

T-2-524 A

T-2-524 B

T-2-524 C

T-2-524 D

T-2-524 E

T-2-524 F

T-2-524 G

K-2-501

ELEV.

PUMPS

K-2-500

T-2-525

C-2-503

"A"

F-2-504 A-G

F-2-503 A-G

F-2-501 A-H

F-2-502 A-F

F-2-500 A-B

"A"

"B"

OFFICE

ELEV.

"A"

T-2-508 LIQUOR SETTLING TANK

C-2-500 TO AMMONIUM SULFATE DECOMPOSITION DWG. L-2-800

CR-2-501 A-J 10-CRYSTALLIZERS

"A"

"B"

"C"

"D"

F-2-500 A-D 4-CRYSTALLIZING TANKS

CR-2-502 A-K 11-CRYSTALLIZERS

CR-2-500 A-F 2-STRINGS TRIPLE EFFECT EVAPORATOR CRYSTALLIZERS

PLAN VIEW

35

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE
F-2-500 TO F-2-504 FLOW DIAGRAMS SHEETS 1 TO 5										

SCALE 0 10 20 30 FT

DRAWN BY H.D.R. DATE 6-2-53

CHECKED BY

CHECKED BY

LOCATION OF JOB

INTERNATIONAL MINERALS & CHEMICAL CORPORATION

ADDRESS MULBERRY, FLORIDA

DIVISION RESEARCH

TITLE

LAYOUT

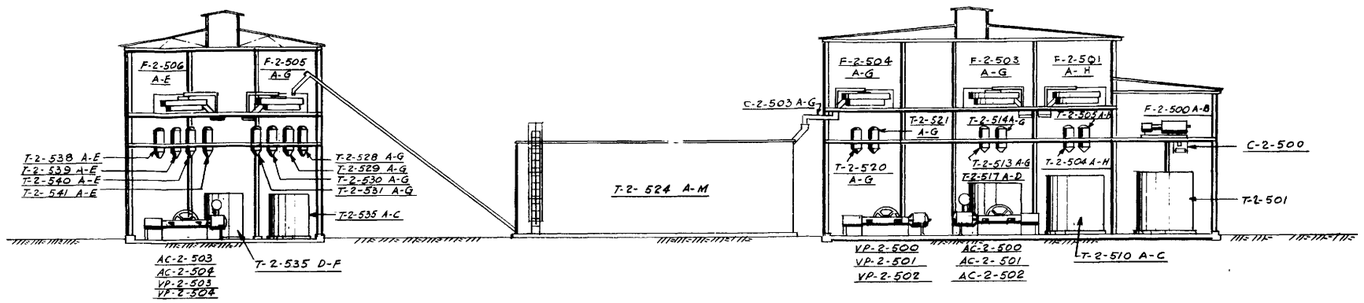
ALUMINA RECOVERY

225 TON UNIT

APPN. NO.

DRWG. NO. L-2-500

FILE NO.



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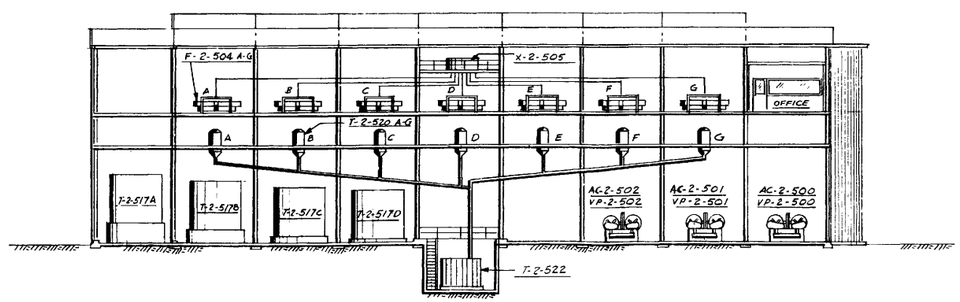

SECTION A-A

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE 0 5 10 15 20 FT	DATE	LOCATION OF JOB	INTERNATIONAL MINERALS & CHEMICAL CORPORATION	TITLE	APPR. NO.
L-2-500 LAYOUT											DRAWN BY H.D.R.	6-16-53		ADDRESS MULBERRY, FLORIDA	SECTIONS ALUMINA RECOVERY 225 TON UNIT	DRWG. NO. L-2-501
											CHECKED BY			DIVISION RESEARCH		FILE NO.
											CHECKED BY					

AMMONIUM SULFATE REMOVAL

C-3-500
1-WEIGH CONVEYOR BELT
12"WIDE x 300'LONG
2 HP DRIVE

WET CAKE TO T-3-800, SHEET F-3-800
11.6 TONS/HR., AMMONIUM SULFATE
0.2 TONS/HR., LIQUOR

F-3-500

CENTRIFUGE FEED
39.5 TONS/HR. SLURRY
108 GPM SP.GR.-1.47

F-3-500
1-CONTINUOUS CENTRIFUGES
8'-6" DIA. x 10'-10" LONG, EACH
50 HP EACH

LIQUOR FROM SECOND ALUM FILTERATION
FROM T-3-515, SHEET F-3-501
196.3 TONS/HR., LIQUOR
660 GPM. SP. GR - 1.20

LIQUOR RECYCLE
FROM CENTRIFUGE
27.7 TPH., LIQUOR
90 GPM. SP.GR.-1.24

CRYSTALLIZER FEED
224 TONS/HR., LIQUOR
750 GPM
SP.GR. - 1.20

T-3-501

P-3-508A-B

T-3-501
1-CRYSTALLIZER FEED TANK
15-MIN. SURGE TIME
13,320 GAL. CAPACITY
13' DIA x 14' HIGH

P-3-508A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
900 GPM, MAX.
750 GPM, OPERATING
SP.GR.-1.20
35' HEAD, 15 HP EACH

$(NH_4)_2SO_4$ RECYCLE STREAM
75.5 TONS/HR. SLURRY
206 GPM SP.GR.-1.47

CRYSTALLIZER PRODUCT
115 TONS/HR., SLURRY
314 GPM. SP.GR. 1.47

COOLING TOWER WATER
4,800 GPM., @ 85° F

AMMONIUM SULFATE CRYSTALLIZATION

E-3-501A-F
6-EXCHANGERS
8675 SQ.F.T. EACH

FIRST EFFECT OVERHEAD
37.7 TONS/HR., WATER

CR-3-500 A-F
2- TRIPLE EFFECT EVAPORATOR CRYSTALLIZERS
EACH CRYSTALLIZING UNIT - 17'-4" DIA.

SECOND EFFECT OVERHEAD
34.7 TONS/HR., WATER

THIRD EFFECT OVERHEAD
36.6 TONS/HR., WATER

COOLING TOWER WATER
71,950 GPM @ 85°F

EJECTOR STEAM
325 LBS/HR
100 PSIG

BC-3-501A-B
2-BAROMETRIC CONDENSERS

STEAM
112,500 LBS/HR
15 PSIG

E-3-501 A-B

CR-3-500 A-B
195°F
212°F

CR-3-500 C-D
153°F
167°F

CR-3-500 E-F
110°F
122°F

E-3-501 C-D

E-3-501 E-F

125°F

CONDENSATE DISCHARGE
2,850 TONS/HR., WATER
11,400 GPM

P-3-509A-C

P-3-510A-C

P-3-509D-F

P-3-510D-F

P-3-509G-I

P-3-510G-I

P-3-511A-C

P-3-509A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
3750 GPM, MAXIMUM
3125 GPM, OPERATING
SP.GR.-1.30
25' HEAD, 60 HP EACH

P-3-510A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
63 GPM, MAXIMUM
53 GPM, OPERATING
SP.GR.-1.30
125' HEAD, 5 HP EACH

P-3-509D-F
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
3750 GPM, MAXIMUM
3125 GPM, OPERATING
SP.GR.-1.40
25' HEAD, 60 HP EACH

P-3-510D-F
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
63 GPM, MAXIMUM
53 GPM, OPERATING
SP.GR.-1.40
125' HEAD, 5 HP. EACH

P-3-509G-I
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
3750 GPM, MAXIMUM
3125 GPM, OPERATING
SP. GR.-1.47
25' HEAD, 60 HP, EACH

P-3-510G-I
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
63 GPM, MAXIMUM
53 GPM, OPERATING
SP. GR. - 1.47
125' HEAD, 5 HP. EACH

P-3-511A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
6850 GPM, MAXIMUM
5700 GPM, OPERATING
SP.GR.-1.00
50' TOTAL HEAD
125 HP EACH

STEAM JET COOLING

EJECTOR STEAM
150 LBS/HR., @ 100 PSIG

SJ-3-500A-B
2-STEAM JET REFRIGERATING UNITS
535 TONS OF REFRIGERATION EACH

COOLING TOWER WATER
5450 GPM @ 85°F

WATER EVAPORATED
6.1 TONS/HR., WATER

BOOSTER STEAM
19,550 LBS/HR.,
100 PSIG

EVAPORATOR DISCHARGE
47.3 TPH. DISSOLVED SOLIDS
110.5 TPH. WATER
460 GPM SP.GR.-1.37

P-3-504 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
385 GPM, MAXIMUM
320 GPM., OPERATING
SP.GR.-1.42
50' HEAD 15 HP EACH

130°F

77°F

SJ-3-500A-B

P-3-504 A-C

P-3-505 A-C

HOT WELL DISCHARGE
1372 TONS/HR. WATER
@ 99° F
5,500 GPM

P-3-505 A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
3300 GPM., MAXIMUM
2750 GPM., OPERATING
SP.GR. 1.00
50' HEAD 60 HP EACH

EVAPORATION OF ACID FILTRATE

E-3-500 A-F
6-EXCHANGERS
2950 SQ. FT. EACH

EV-3-500 A-F
2-TRIPLE EFFECT EVAPORATORS
EACH EVAPORATOR UNIT 12'-3" DIA.

TOTAL OVERHEAD
50.6 TONS/HR, WATER

EJECTOR STEAM
150 LBS/HR, @ 100 PSIG

BC-3-500A-B
2-BAROMETRIC CONDENSERS

STEAM
63,400 LBS/HR.
100 PSIG

338°F

E-3-500 A-B

EV-3-500 A-B
189°F

E-3-500 C-D

EV-3-500 C-D
150°F

E-3-500 E-F

EV-3-500 E-F

130°F

CLARIFIED ACID FILTRATE
FROM T-3-306, DWG. F-3-301
47.3 TONS/HR. DISS. SOLIDS
161.1 TONS/HR. WATER
662 GPM SP.GR.-1.26

200°F

160°F

110°F

P-3-500 A-C

P-3-501A-C

P-3-502 A-C

CONDENSED DISCHARGE
1250 TONS/HR. WATER
5000 GPM

FEED ANALYSIS
9-TPH P_2O_5
11.0-TPH Al_2O_3
1.3-TPH Fe_2O_3
28.6-TPH SO_4
0.0144-TPH U_3O_8

P-3-500A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
10,000 GPM., MAXIMUM
8,325 GPM., OPERATING
SP.GR.-1.30
20' HEAD, 100 HP. EACH

P-3-501A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
8,925 GPM, MAXIMUM
7,450 GPM., OPERATING
SP.GR.-1.34
20' HEAD, 100 HP. EACH

P-3-502A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
7,450 GPM., MAXIMUM
6600 GPM., OPERATING
SP.GR.-1.37
20' HEAD, 75 HP. EACH

P-3-502A-C
3-CENTRIFUGAL PUMPS
2-OPERATING, 1-SPARE
3000 GPM, MAXIMUM
2500 GPM, OPERATING
SP.GR.-1.0
50' HEAD, 50 HP. EACH

FIRST ALUM CRYSTALLIZATION

CRYSTAL RECYCLE FROM
T-3-508, SHEET F-3-501
2.4 TONS/HR., ALUM 23 GPM
5.5 TONS/HR., LIQUOR-SP.GR.1.36

E-3-502 A-D
4-COOLING COILS
4,660 SQ.FT. AREA, EACH
15,700,000 BTU/HR., TOTAL

DEEP WELL WATER
7,780 GPM @ 72°F

FEED TO FILTER F-3-501 SHEET F-3-501
235.1 TONS/HR. SLURRY
663 GPM SP.GR.-1.42

77° F

T-3-500A
E-3-502 A
R-3-500A

T-3-500B
E-3-502 B
R-3-500B

T-3-500C
E-3-502 C
R-3-500C

T-3-500D
E-3-502 D
R-3-500D

P-3-506A-B

P-3-506C-D

P-3-506E-F

P-3-507A-B

FEED TO FIRST ALUM CRYSTALLIZERS
227.2 TONS/HR. SLURRY
640 GPM SP.GR. - 1.42

T-3-500A-D
4-CRYSTALLIZERS
5 HRS. RETENTION TIME TOTAL
55,000 GAL. CAPACITY EACH
32' DIA. x 10'x 2' CONE

R-3-500A-D
4-RAKE MECHANISMS
5 HP EACH

P-3-506A-F
6-CENTRIFUGAL PUMPS
3-OPERATING, 3-SPARE
720 GPM, MAX.
640 GPM, OPERATING
SP.GR.-1.42
30' HEAD, 15 HP EACH

P-3-507A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
800 GPM, MAXIMUM
663 GPM, OPERATING
SP.GR.-1.40
50' HEAD, 25 HP EACH

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REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE
F-3-501 PROCESS FLOW DIAGRAM NO.2										
F-3-502 " " " NO.3										
F-3-503 " " " NO.4										
F-3-504 " " " NO.5										

SCALE ...
DRAWN BY E.P.P. - L.W.C. DATE 5-25-53
CHECKED BY
CHECKED BY
LOCATION OF JOB

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
100 TON UNIT
SHEET 1 OF 5

APPN. NO.
DRWG. NO. F-3-500
FILE NO.

~FIRST ALUM FILTRATION~ ~FIRST REDISSOLVING OF ALUM~ ~SECOND ALUM CRYSTALLIZATION~ ~SECOND ALUM FILTRATION~

$(NH_4)_2SO_4$ WASH TO T-3-501 DWG. F-3-500
136.3 TONS/HR. LIQUOR - 660 GPM SP.GR. 1.20

CRYSTALLIZER FEED
FROM T-3-500 DWG F-3-500
285.1 TONS/HR. SLURRY
663 G.P.M. SP.GR. 1.42

X-3-500
SLURRY DISTRIBUTOR
2-MIN. RETENTION TIME
1390 GAL. CAPACITY
6'-6" DIA. x 6'-6"

X-3-501
WASH LIQUID DISTRIBUTOR
5-MIN. RETENTION TIME
800 GAL. CAPACITY
5' DIA. x 6'

77°F

X-3-500 X-3-501

C-3-501
1'-BELT CONVEYOR
20" x 200' LONG
3 H.P. DRIVE

F-3-501 A-D
4- HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE 1.5 H.P.

F-3-501 A-D

T-3-502
COMPRESSED AIR RECEIVER
3'-6" DIA. x 10'

T-3-503
VACUUM SCRUBBER
3' DIA. x 15'

T-3-502 T-3-503 T-3-504 A-D T-3-505 A-D

T-3-504 A-D
4-FILTRATE RECEIVERS
1-MIN. RETENTION TIME
117 GAL. CAP. EACH
2' DIA. x 5'

T-3-505 A-D
4-WASH RECEIVERS
1-MIN. RETENTION TIME EA.
117 GAL. CAPACITY EACH
2' DIA. x 5'

FILTRATE
24 TONS/HR. ALUM CRYSTALS
116.6 TONS/HR. LIQUOR - 374 GPM SP.GR. 1.27

T-3-506 T-3-507

T-3-507
1-WASH LIQUOR SURGE TANK
3-MIN. RETENTION TIME
2220 GAL. CAPACITY
7' x 7' x 6' DEEP

T-3-506
FILTRATE SURGE TANK
5 MIN. RETENTION TIME
2220 GAL. CAPACITY
7'x7'x6' DEEP

P-3-512 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
448 GPM. MAX.
374 GPM. OPERATING
SP.GR. - 1.27
50' HEAD 15 HP. EACH

P-3-512 A-B

AC-3-500
AIR COMPRESSOR
1330 CFM
175 H.P.

VP-3-500
VACUUM PUMP
8900 CFM
350 H.P.

FEED TO URANIUM RECOVERY T-3-602, DWG F-3-600
110.5 TONS/HR. LIQUOR 330 GPM SP.GR.-1.27
COMPOSITION
SO_4 - 18.30 TONS/HR
NH_3 - 6.31 TONS/HR
P_2O_5 - 5.00 TONS/HR
Al_2O_3 - 0.55 TONS/HR
Fe_2O_3 - 1.29 TONS/HR.
U_3O_8 - 0.0144 TONS/HR.

P-3-542 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
&20-GPM MAX.
350 GPM OPER
SP. GR.-1.27
100' HEAD 20 HP. EACH

P-3-542 A-B

T-3-508
77°F

T-3-508
FILTRATE SURGE & SETTLING TANK
3-HR. RESIDENCE TIME
101,000 GAL. CAPACITY
35' DIA. x 14'

R-3-508
SETTLING RAKE
7.5 H.P. DRIVE

R-3-508

CRYSTAL RECYCLE TO T-3-500
DWG. F-3-500
2.4 TONS/HR. ALUM CRYSTALS 23 G.P.M
5.6 TONS/HR. LIQUOR - SP. GR. 1.36

P-3-514 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
28 GPM MAXIMUM
23 GPM OPERATING
SP.GR. 1.36 1.5 H.P. EACH
50' HEAD

P-3-514 A-B

FILTRATE FROM THIRD ALUM FILTRATION
121.0 TONS/HR. 411 GPM, SP.GR. 1.18

WASH LIQUOR TO 1ST ALUM FILTRATION
98.9 TONS/HR. LIQUOR
329 G.P.M SP.GR. 1.20

FILTER FEED
313.5 TONS/HR. SLURRY
953 GPM SP.GR. 1.32

FILTER CAKE
17 TONS/HR. LIQUOR
99.3 TONS/HR. ALUM

T-3-510 A-D
4-ALUM REDISSOLVING TANKS
30 MIN. RETENTION TIME
11,100 GAL. CAPACITY
13' DIA. x 12'

A-3-510 A-H
8-SIDE ENTERING AGITATORS
6-H.P. DRIVE EACH

C.R.-3-501 A-E
5-VACUUM CRYSTALLIZERS
EACH UNIT 26' DIA.

SJ-3-501 A-E
5-STEAM JET REFRIGERATION UNITS
860 TONS OF REFRIGERATION EACH

77°F

T-3-510 A T-3-510 B T-3-510 C T-3-510 D

A-3-510 A-B E-3-503 A E-3-503 B A-3-510 C-D A-3-510 E-F E-3-503 C E-3-503 D A-3-510 G-H

EVAPORATED WATER
23.6 TONS/HR. WATER

COOLING TOWER WATER
20,600 GPM @ 85°F

HEATING STEAM
30,000 LBS./HR.
@ 100 PSIG

EJECTOR STEAM
576 LBS/HR. 100 PSIG

FEED TO POLISHING FILTER
337.1 TONS/HR. LIQUOR
1045 GPM SP.GR. 1.27

E-3-506 A-D
4-STEAM COILS
1380 SQ.FT. AREA EACH
29,800,000 BTU/HR. TOTAL

160°F

BOOSTER STEAM
87,800 LBS/HR.
@ 100 PSIG

WASH LIQUOR FILTRATE
98.9 TONS/HR. LIQUOR
329 GPM
SP.GR. 1.20

X-3-515
LIQUOR DISTRIBUTOR
1-MIN. RESIDENCE TIME
1250 GAL. CAPACITY
6' DIA. x 6'

SJ-3-501 A-E

D-3-515 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1255 GPM MAXIMUM
1045 GPM OPERATING
SP.GR. 1.27 75 H.P. EACH
125' HEAD

160°F

X-3-515

C.R.-3-501
81°F

F-3-502 A-B F-3-502 C-D

F-3-502 A-D
4-POLISHING FILTERS
2-OPERATING, 2-OFF-STREAM
1304 SQ. FT. EACH

P-3-519 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
393 G.P.M. MAXIMUM
329 G.P.M. OPERATING
SP.GR. 1.20 10 H.P. EACH
50' HEAD

P-3-517 A-F
6-CENTRIFUGAL PUMPS
5-OPERATING, 1-SPARE
3100 GPM MAX. EACH
2580 GPM OPERATING
SP.GR. 1.32
25' HEAD 100 H.P. EACH

P-3-518 A-F
6-CENTRIFUGAL PUMPS
5-OPERATING, 1-SPARE
860 GPM MAXIMUM EACH
212 GPM OPERATING
SP.GR. 1.32
50' HEAD 10 H.P. EACH

T-3-509
FILTRATE SURGE TANK
3-MIN. SURGE TIME
6300 GAL. CAPACITY
10'-DIA. x 11'

T-3-509

P-3-516 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1255 GPM. MAXIMUM
1045 GPM. OPERATING
SP.GR. 1.27 30 H.P. EACH
50' HEAD

FEED TO ALUM CRYSTALLIZERS
337.1 TONS/HR. LIQUOR
1045 GPM SP.GR. 1.29

FILTRATE FROM THIRD ALUM FILTRATION
T-3-502 DWG. F-3-502
227.9 TONS/HR. LIQUOR, 748 GPM SP.GR. 1.18

X-3-502
SLURRY DISTRIBUTOR
2-MIN. SURGE TIME
4300 GAL. CAPACITY
7'-6" DIA. x 7' HIGH

X-3-503
WASH LIQUOR DISTRIBUTOR
2-MIN. SURGE TIME
810 GAL. CAPACITY
5' DIA. x 6' HIGH

X-3-502 X-3-503

WASH LIQUOR TO
2ND ALUM FILTRATION
33.8 TONS/HR. LIQUOR
338 G.P.M. - SP.GR. 1.18

FILTER CAKE TO
T-3-517, DWG. F-3-502
17 TONS/HR. LIQUOR
100.2 TONS/HR. ALUM

F-3-503 A-C
3-HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE - 1.5 H.P.

F-3-503 A-C

C-3-502
BELT CONVEYOR
20"-WIDE x 200'-LONG
3 H.P. DRIVE

T-3-511 T-3-512 T-3-513 A-C T-3-514 A-C

T-3-513 A-C
3-FILTRATE RECEIVERS
1-MIN. RETENTION TIME EA.
875 GAL. CAP. EACH
3' DIA. x 5'-6"

T-3-514 A-C
3-WASH RECEIVERS
1-MIN. RETENTION TIME EA.
140 GAL. CAP. EACH
2' DIA. x 6'

T-3-511
COMPRESSED AIR RECEIVER
3'-6" DIA. x 10'

T-3-512
1-VACUUM SCRUBBERS
3' DIA. x 15'

WASH LIQUOR
99.8 TONS/HR. LIQUOR
338 GPM - SP.GR. 1.18

T-3-515 T-3-516

T-3-515
1-FILTRATE SURGE TANK
5-MIN. RESIDENCE TIME EA.
4,000 GAL. CAP. EACH
8' x 8' x 9' DEEP

T-3-516
1-WASH LIQUOR SURGE TANK
5-MIN. RESIDENCE TIME EA.
2000 GAL. CAP. EACH
6' x 6' x 8' DEEP

AC-3-501
AIR COMPRESSOR
1330 CFM
175 H.P.

VP-3-501
1-VACUUM PUMP
8900 CFM
350 H.P.

FILTRATE
196.3 TONS/HR. LIQUOR - 660 GPM - SP.GR. 1.20

P-3-520 A-B P-3-521 A-B

P-3-520 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
724 GPM MAXIMUM
660 GPM OPERATING
SP.GR. 1.20 - 25 H.P. EACH
50' HEAD

P-3-521 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
908 GPM MAXIMUM
338 GPM OPERATING
SP.GR. 1.18 - 10 H.P. EACH
50' HEAD

HOT WELL DISCHARGE
3200 TONS/HR. WATER
20,800 GPM @ 93°F

P-3-519 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
25,000 GPM MAX. EACH
20,800 GPM OPERATING
SP.GR. 1.0
50' HEAD 400 H.P. EACH

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REFERENCE DRAWINGS		MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE
F-3-500, PROCESS FLOW DIAG. SHEET 1											
F-3-502, " " " "	3										
F-3-503, " " " "	4										
F-3-504, " " " "	5										

		DATE	LOCATION OF JOB
DRAWN BY	L.W.C. 8-Pp		
CHECKED BY			
CHECKED BY			

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
100 TON UNIT
SHEET 2 OF 5

APPN. NO.
DRWG. NO. F-3-501
FILE NO.

— SECOND REDISSOLVING OF ALUM — — THIRD ALUM CRYSTALLIZATION — — THIRD ALUM FILTRATION — — $Al(OH)_3$ PRECIPITATION — — NH_4OH MAKE-UP —

LIQUOR FROM THIRD ALUM TO F-3-503, SHEET F-3-501
220.8 TONS/HR., LIQUOR
SP. GR. - 1.18 748 GPM

212° F

23.5 WT. % $(NH_4)_2SO_4$ SOLUTION
110.1 TONS/HR., WATER
34.0 TONS/HR., $(NH_4)_2SO_4$
516 GPM SP. GR. - 1.14

CAKE FROM C-3-502, SHEET F-3-501
100.2 TONS/HR., ALUM
17.0 TONS/HR., LIQUOR

81° F

T-3-517 A-D
4- ALUM RESOLUTION TANKS
30 MIN. TOTAL RETENTION TIME
10,200 GAL. CAPACITY EACH
12' DIA. x 12' HIGH

A-3-517 A-H
8-SIDE ENTERING AGITATORS
7.5 H.P. DRIVE EACH

E-3-504 A-D
4-STEAM COILS
490 - 50 FT. TOTAL
7,360,000 BTU/HR.

X-3-504
1-DISTRIBUTOR
2-MIN. RETENTION TIME
2,800 GAL. CAPACITY EACH
8'-0" DIA. x 7' HIGH

3RD CRYSTALLIZER FEED
357.0 TONS/HR. LIQUOR
1134 GPM. SP. GR. 1.26

160° F

P-3-527A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1365 GPM MAXIMUM
1134 GPM OPERATING
SP. GR. 1.26 40 H.P. EACH
50' HEAD

WASH FROM 3RD ALUM FILTRATION
70.9 TONS/HR. WATER
21.8 TONS/HR. $(NH_4)_2SO_4$
3.0 TONS/HR. ALUM
317 GPM SP. GR. 1.14

P-3-528 A-F
6-CENTRIFUGAL PUMPS
5-OPERATING, 1-SPARE
250 GPM, MAXIMUM
208 GPM, OPERATING
SP. GR. - 1.28 10 HP. EACH
50' HEAD

81° F

P-3-529 A-F
6-CENTRIFUGAL PUMPS
5-OPERATING, 1-SPARE
250 GPM, MAXIMUM
208 GPM, OPERATING
SP. GR. - 1.28 10 HP. EACH
50' HEAD

P-3-525 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
25,100 GPM, MAXIMUM
21,360 GPM, OPERATING
SP. GR. - 1.00
50' HEAD 425 H.P. EACH

HOT WELL DISCHARGE
5,340 TONS/HR., WATER
21,360 GPM @ 99° F

STEAM
8,000 LBS./HR. @ 100 PSIG

WATER EVAPORATED
24.2 TONS/HR., WATER

COOLING TOWER WATER
21,000 GPM @ 85° F

BOOSTER STEAM
90,000 LBS/HR. @ 100 PSIG

EJECTOR STEAM
589 LBS/HR @ 100 PSIG

SJ-3-502 A-E
5- STEAM JET REFRIGERATING UNITS
800 TONS OF REFRIGERATION EACH

CR-3-502 A-E
5- VACUUM CRYSTALLIZERS
EACH CRYSTALLIZING UNIT - 26' DIA

FILTER FEED
332.8 TONS/HR., SLURRY
SP. GR. - 1.28 1040 GPM

F-3-504 A-C
3-HORIZONTAL FILTERS
15' DIA. EACH
3 H.P. DRIVE EACH
SCROLL DISCHARGE - 15 H.P.

X-3-505
SLURRY DISTRIBUTOR
2-MIN. RETENTION TIME
2900 GAL CAPACITY
8' DIA. x 8' HIGH

X-3-506
WASH LIQUOR DISTRIBUTOR
2-MIN. RETENTION TIME
770 GAL. CAPACITY
6' DIA. x 5' HIGH

AC-3-502
1-AIR COMPRESSOR
1330 CFM
175 - H.P.

VD-3-502
1-VACUUM PUMPS
8900 CFM
350 HP.

T-3-518

T-3-519

T-3-519
VACUUM SCRUBBER
5' DIA. x 15' HIGH

T-3-518
COMPRESSED AIR SURGE TANK
3'-6" DIA. x 10' HIGH

T-3-520 A-C
3-FILTRATE RECEIVERS
1-MIN. RETENTION TIME EACH
315 - GAL. CAPACITY EACH
3' DIA. x 6' HIGH

T-3-521 A-C
3-WASH LIQUOR RECEIVERS
1-MIN. RETENTION TIME EACH
132 - GAL. CAPACITY EACH
2' DIA. x 6' HIGH

T-3-522

T-3-523

P-3-526 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
834 GPM MAXIMUM
748 GPM OPERATING
SP. GR. 1.183 25 H.P. EACH
50' HEAD

P-3-527 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
384 GPM MAXIMUM
317 GPM OPERATING
SP. GR. 1.14 10 H.P. EACH
50' TOTAL HEAD

T-3-522
1-FILTRATE SURGE TANK
5-MIN. RETENTION TIME
4,400 GAL. CAP.
8' x 8' x 10' DEEP

T-3-523
WASH LIQUOR SURGE TANK
5-MIN. RETENTION TIME
1000 GAL. CAPACITY
6' x 6' x 6' DEEP

P-3-526 A-B

P-3-527 A-B

C-3-503 A-C
3-SCREW CONVEYORS
24" DIA. x 28' LONG
7500 CU. FT./HR. SOLIDS
10 HP. DRIVE 55 RPM

FILTER CAKE
92.7 TONS/HR. ALUM CRYSTALS
0.5 TONS/HR. ALUM IN SOLUTION
3.8 TONS/HR. $(NH_4)_2SO_4$ IN SOLUTION
12.0 TONS/HR. WATER

85% NH_3 FEED
21.0 TONS/HR. NH_3
62.8 TONS/HR. WATER
SP. GR. 0.91

FEED TO FIRST $Al(OH)_3$ PRECIPITATION
10.5 TONS/HR. NH_3
58.2 TONS/HR. $(NH_4)_2SO_4$
16.0 TONS/HR. $Al(OH)_3$
108.1 TONS/HR. WATER
638 GPM SP. GR. 1.21

C-3-503 A-C

T-3-524 A-C

P-3-528 A-D
4-CENTRIFUGAL PUMPS
3-OPERATING, 1-SPARE
240 GPM, MAXIMUM
200 GPM, OPERATING
SP. GR. - 1.00 5 HP.
50' HEAD

T-3-524 A-C
3- PRECIPITATION TANKS
12'- WIDE x 85' LONG x 30' HIGH
3-HRS. RETENTION TIME
8- HORIZ. APRON CONVEYORS (FLIGHTS ATTACHED) PER TANK
1- INCLINED APRON CONVEYOR (FLIGHTS ATTACHED) PER TANK
12' WIDE x 80' LONG — 6" FLIGHTS EACH

WASH AMMONIUM SOLUTION FROM K-3-800, SHEET F-3-801
9.2 TONS/HR. NH_3 295 GPM
62.8 TONS/HR. WATER - SP. GR. 0.981

K-3-500

FILTRATE
220.8 TONS/HR, LIQUOR
748 GPM SP. GR. - 1.18

T-3-525

NH_3 MAKE-UP
1.3 TONS/HR. NH_3
9.7 GPM
SP. GR. 0.597

P-3-529
1-CENTRIFUGAL PUMP
225 GPM, OPERATING
SP. GR. - 0.60
100' HEAD 7.5 HP.

T-3-525
1-LIQUID NH_3 STORAGE TANK
8 HR. TOTAL CAPACITY
3100 GAL. CAPACITY
5' DIA. x 20' LONG

P-3-530 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
444 GPM, MAXIMUM
369 GPM, OPERATING
SP. GR. - 0.91 7.5 HP. EACH
50' HEAD

K-3-500
AMMONIA ABSORPTION COLUMN
6'-6" DIA. x 50' HIGH

AMMONIA FROM K-3-501, SHEET F-3-503
10.5 TONS/HR., NH_3

AMMONIUM SULFATE SOLUTION @ 81° F
FROM K-3-501, SHEET F-3-503
70.9 TONS/HR., WATER 319 GPM
21.8 TONS/HR., $(NH_4)_2SO_4$ SP. GR. 1.14

AMMONIUM SULFATE SOLUTION @ 212° F FROM F-3-501, SHEET F-3-503
110.1 TONS/HR., WATER 515 GPM
34.1 TONS/HR., $(NH_4)_2SO_4$ SP. GR. - 1.14

WASH LIQUOR FROM 3RD ALUM FILTER
70.5 TONS/HR. WATER
21.8 TONS/HR. $(NH_4)_2SO_4$
3.0 TONS/HR. ALUM
317 GPM
SP. GR. 1.14

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE
F-3-500 - PROCESS FLOW DIAGRAM - SHT. 1										
F-3-501 " " " - 2										
F-3-503 " " " - 4										
F-3-504 " " " - 5										

SCALE — DATE — LOCATION OF JOB

DRAWN BY H.D.R.-E.P.P.
CHECKED BY
CHECKED BY

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE: PROCESS FLOW DIAGRAM ALUMINA RECOVERY 100 TON UNIT SHEET No. 3 OF 5

APPN. NO.
DRWG. NO. F-3-502
FILE NO.

~ FIRST $AL(OH)_3$ FILTRATION ~

~ $AL(OH)_3$ REPULPING ~

~ SECOND $AL(OH)_3$ FILTRATION ~

~ AMMONIA RECOVERY ~

FEED FROM T-3-524 DWG. F-3-503
192.8 TONS/HR. SLURRY
638 GPM, SP.GR. 1.21
COMPOSITION:
FREE NH_3 10.5 TONS/HR.
$(NH_4)_2SO_4$ 58.2 " "
$AL(OH)_3$ 16.0 " "
WATER 108.1 " "

X-3-507
SLURRY DISTRIBUTOR
2-MIN. RESIDENCE TIME
1530 GAL. CAPACITY
7' DIA x 6'

X-3-508
WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
1250 GAL. CAPACITY
6' DIA. x 6'

X-3-509
WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
1250 GAL. CAPACITY
6' DIA. x 6'

X-3-510
WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
1250 GAL. CAP.
6' DIA. x 6'

WASH LIQUOR
133.0 TONS/HR., LIQUOR
2.3 TONS/HR. NH_3
6.0 TONS/HR. SO_4
518 GPM SP.GR. 1.04

FILTER FEED
213.7 TONS/HR. TOTAL SLURRY
4.3 TONS/HR. NH_3 790 GPM
10.7 TONS/HR. SO_4 SP.GR. 1.09

X-3-511
SLURRY DISTRIBUTOR
2-MIN. RESIDENCE TIME
2110 GAL. CAPACITY
7' DIA. x 8'

X-1-512
WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
1270 GAL. CAP.
6' DIA x 6'

X-3-513
WASH LIQUOR DISTRIBUTOR
2-MIN. RESIDENCE TIME
1270 GAL. CAP.
6' DIA. x 6'

X-3-514
WATER WASH DISTRIBUTOR
2-MIN. RESIDENCE TIME
1270 GAL. CAP.
6' DIA. x 6'

WATER WASH
137.0 TONS/HR., WATER
525 GPM

F-3-505 A-C
3 - HORIZONTAL FILTERS
15' DIA. EACH
3 - H.P. DRIVE
1.5 H.P. SCROLL DISCHARGE

F-3-506 A-C
3 - HORIZONTAL FILTERS
15' DIA. EACH
3 H.A. DRIVE EACH
1.5 H.P. SCROLL DISCHARGE

RESOLUTION LIQUOR
135.2 TONS/HR. LIQUOR
1.2 TONS/HR. NH_3
30 TONS/HR. SO_4
534 GPM SP.GR.: 1.02

C-3-504
1 - CONVEYER BELT
18" x 200' LONG
3 - H.P. EACH

C-3-505

C-3-508
1-CONVEYER BELT
18" x 90' LONG
3 - H.P. EACH

WET CAKE TO T-3-547, DWG. F-3-504
76.5 TONS/HR. TOTAL WET CAKE
COMPOSITION

Al_2O_3	10.5	TONS/HR.
SO_4	1.8	" "
NH_3	0.6	" "
H_2O	58.1	" "

FILTER CAKE
78.5 TONS/HR. TOTAL WET CAKE
3.0 TONS/HR. NH_3
7.7 TONS/HR. SO_4

T-3-526
COMPRESSED AIR SURGE TANK
3'6" DIA. x 10'

T-3-527
VACUUM SCRUBBER
5' DIA. x 15'

T-3-528 A-C
T-3-529 A-C
T-3-530 A-C
T-3-531 A-C

T-3-535 A
A-3-535 A-B
T-3-535 B
A-3-535 C-D
T-3-535 C
A-3-535 E-F

T-3-528 A-C
3 - FILTRATE RECEIVERS
1 - MIN. RESIDENCE TIME
170 GAL. CAP. EACH
2'-6" DIA. x 5'

T-3-535 A-C
3 - REPULPING TANKS
5 - MIN. RETENTION TIME TOTAL
4740 GAL. CAP. EACH
9' DIA. x 10' DEEP

A-3-535 A-F
6 - SIDE ENTERING AGITATORS
3 - H.P. EACH

T-3-529 A-C
3 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
215 GAL. CAP. EACH
2'-6" DIA. x 6'

T-3-530 A-C
3 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
215 GAL. CAP. EACH
2'-6" DIA. x 6'

T-3-531 A-C
3 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
215 GAL. CAP. EACH
2'-6" DIA. x 6'

T-3-536
COMPRESSED AIR SURGE TANK
3'6" DIA. x 10'

T-3-537
VACUUM SCRUBBER
5' DIA. x 15'

T-3-538 A-C
T-3-539 A-C
T-3-540 A-C
T-3-541 A-C

T-3-538 A-C
3 - FILTRATE RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAP. EACH
3' DIA. x 6'

T-3-539 A-C
3 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAP. EACH
3' DIA. x 6'

T-3-540 A-C
3 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAP. EACH
3' DIA. x 6'

T-3-541 A-C
3 - WASH RECEIVERS
1 - MIN. RESIDENCE TIME
285 GAL. CAP. EACH
3' DIA. x 6'

STRIPPER FEED
247.3 TONS/HR. TOTAL LIQUOR
55.9 TONS/HR. $(NH_4)_2SO_4$
10.5 TONS/HR. NH_3 - 915 GPM
180.9 TONS/HR. WATER - SP.GR. 1.09

DEEP WELL WATER
667 GPM @ 72°F

E-3-505

AMMONIA TO K-3-500, DWG. F-3-502
10.5 TONS/HR. NH_3

72°F
105°F

E-3-505
HEAT EXCHANGER
2220 SQ. FT.

K-3-501
AMMONIA STRIPPING COLUMN
3'-4" DIA. x 50'

E-3-506
HEAT EXCHANGER
2,740 SQ. FT.

STEAM
64,500 Lbs./Hr.
@ 15 PSIG

FILTRATE
118.2 TONS/HR. LIQUOR
20.0 TONS/HR. NH_3 - 410 GPM
28.7 TONS/HR. SO_4 SP.GR. 1.09

FINAL WASH SOLUTION
135.1 TONS/HR. LIQUOR
4.9 TONS/HR. NH_3 - 505 GPM
11.9 TONS/HR. SO_4 - SP.GR. 1.07

No. 2 WASH
No. 1 WASH

FILTRATE
133.0 TONS/HR. TOTAL LIQUOR
2.3 TONS/HR. NH_3 - 312 GPM
6.0 TONS/HR. SO_4 - SP.GR. 1.04

No. 3 WASH
No. 2 WASH
No. 1 Wash

FINAL WASH SOLUTION
135.2 TONS/HR. LIQUOR
1.2 TONS/HR. NH_3 - 534 GPM
3.0 TONS/HR. SO_4 - SP.GR. 1.02

AC-3-503
1-AIR COMPRESSOR
1330 CFM EACH
175 HP EACH

VP-3-503
1-VACUUM PUMP
8900 CFM
350 H.P.

AC-3-504
1-AIR COMPRESSOR
880 CFM.
125 H.P.

VP-3-504
1-VACUUM PUMP
1-OPERATING, 1-SPARE
6700 CFM, EACH
300 H.P. EACH

T-3-532
T-3-533
T-3-534
T-3-542
T-3-543
T-3-544
T-3-545

P-3-531 A-B
P-3-532 A-B
P-3-533 A-B
P-3-534 A-B
P-3-535 A-B
P-3-536 A-B
P-3-537 A-B
P-3-538 A-B

T-3-532
FILTRATE SURGE TANK
5-MIN. RESIDENCE TIME
5200 GAL. CAP.
9' x 9' x 8' DEEP

T-3-533
1 - WASH SURGE TANK
2-MIN. RESIDENCE TIME
3110 GAL. CAP.
7' x 7' x 8'6" DEEP

T-3-534
1 - WASH SURGE TANK
2-MIN. RESIDENCE TIME
3110 GAL. CAP.
7' x 7' x 8'6" DEEP

FILTRATE
247.3 TONS/HR. LIQUOR
55.9 TONS/HR. $(NH_4)_2SO_4$
10.5 TONS/HR. NH_3
180.9 TONS/HR. WATER
315 GPM
SP.GR. 1.09

T-3-542
FILTRATE SURGE TANK
5-MIN. RESIDENCE TIME
3110 GAL. CAP.
7' x 7' x 8'6" DEEP

T-3-543
1 - WASH SURGE TANK
5 MIN. RESIDENCE TIME
3110 GAL. CAP.
7' x 7' x 8'6" DEEP

T-3-544
1 - WASH SURGE TANK
5 MIN. RESIDENCE TIME
3110 GAL. CAP.
7' x 7' x 8'6" DEEP

T-3-545
1 - WASH SURGE TANK
5-MIN. RESIDENCE TIME
3110 GAL. CAPACITY
7' x 7' x 8'6" DEEP

P-3-531 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1080 GPM MAX. EACH
915 GPM OPERATING
SP.GR. 1.09
50' HEAD 25 H.P. EACH

P-3-532 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
618 GPM MAX. EACH
516 GPM OPERATING
SP.GR. 1.06
50' HEAD 15 H.P. EACH

P-3-533 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
618 GPM MAX.
516 GPM OPERATING
SP.GR. 1.04
50' HEAD 15 HP EACH

P-3-534 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
946 GPM, MAX.
790 GPM, OPERATING
SP.GR. 1.09
50' HEAD, 20 HP EACH

P-3-535 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
616 GPM, MAX.
512 GPM, OPERATING
SP.GR. 1.035
50' HEAD, 15 H.P. EACH

P-3-536 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
640 GPM. MAX
534 GPM OPERATING
SP.GR. - 1.02
50' HEAD, 15 H.P. EACH

P-3-537 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
635 GPM, MAX. EACH
530 GPM, OPERATING
SP.GR. - 1.01
50' HEAD, 15 H.P. EACH

P-3-538 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
630 GPM, MAX. EACH
525 GPM, OPERATING
SP.GR. - 1.0
50' HEAD, 15 H.P. EACH

DEEPWELL WATER
1150 GPM @ 72°F

P-3-539 A-B
2-CENTRIFUGAL PUMPS
1-OPERATING, 1-SPARE
1200 GPM MAX. EACH
835 GPM OPERATING
SP.GR. 1.14
100' HEAD 40 H.P. EACH

212°F
81°F
212°F

AMMONIUM SULFATE SOLUTION TO X-3-506, DWG. F-3-502
70.9 TONS/HR. WATER
21.8 TONS/HR $(NH_4)_2SO_4$
319 GPM SP.GR. 1.13

AMMONIUM SULFATE SOLUTION TO T-3-517, DWG. F-3-502
110.1 TONS/HR. WATER 515 GPM
38.1 TONS/HR. $(NH_4)_2SO_4$, SP.GR. 1.14

40

REFERENCE DRAWINGS					MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE	DATE	LOCATION OF JOB
F-3-500, PROCESS FLOW DIAG.	SHEET	1													DRAWN BY L.W.C. 4-64		
F-3-501, "	"	2													CHECKED BY		
F-3-502, "	"	3													CHECKED BY		
F-3-504, "	"	5															

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

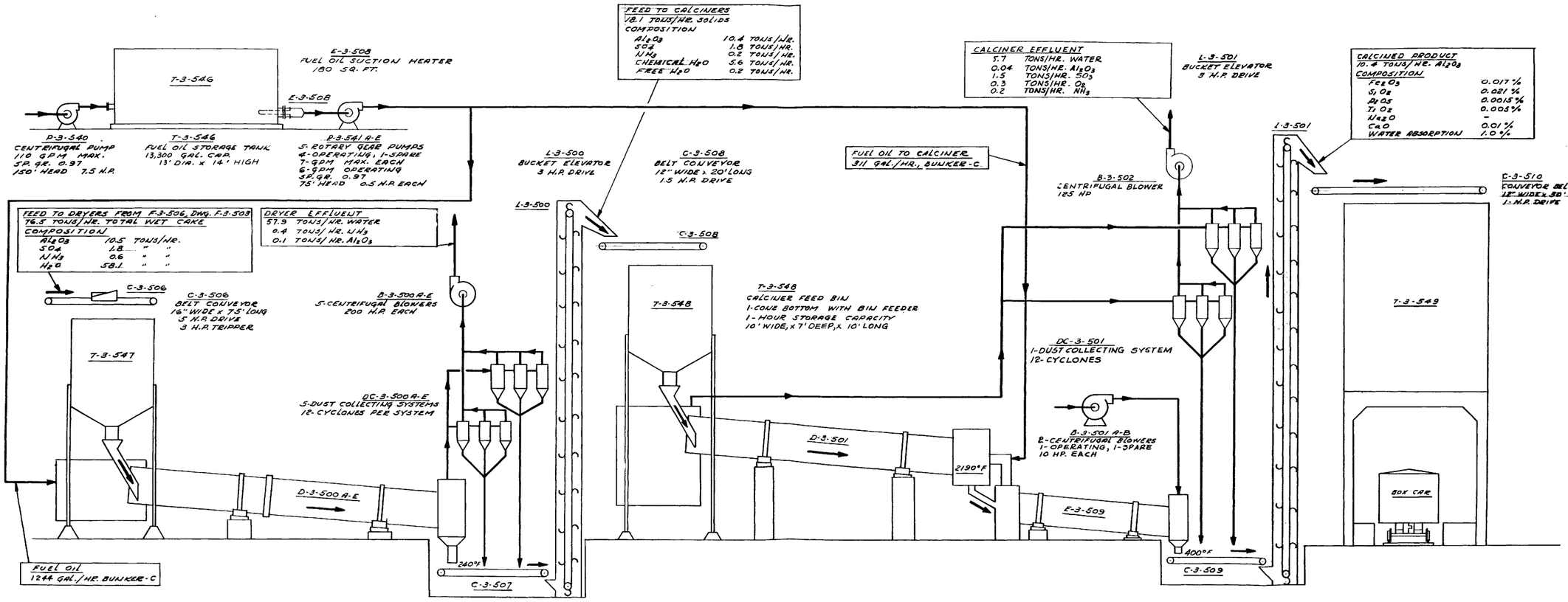
TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
100 TON UNIT
SHEET 4 OF 5

APPN. NO.
DRWG. NO. F-3-503
FILE NO.

DRYING

CALCINING & COOLING

STORAGE & SHIPPING



T-3-547
DRYER FEED BIN
5-CONE BOTTOMS WITH BIN FEEDERS
8-HOUR STORAGE CAP.
15' x 20' DEEP x 75' LONG

D-3-500 A-E
5-ROTARY DRYERS
8' DIA. x 80' LONG
200 H.P. DRIVE EACH

C-3-507
BELT CONVEYOR
12" WIDE x 130' LONG
2 H.P. DRIVE

D-3-501
1-ROTARY CALCINER
6' DIA. x 150' LONG
2-20 H.P. DRIVES

E-3-509
1-ROTARY COOLER
7' DIA. x 50' LONG
25 H.P. DRIVE

C-3-509
DRAG CONVEYOR
18" WIDE x 250' LONG
3 H.P. DRIVE

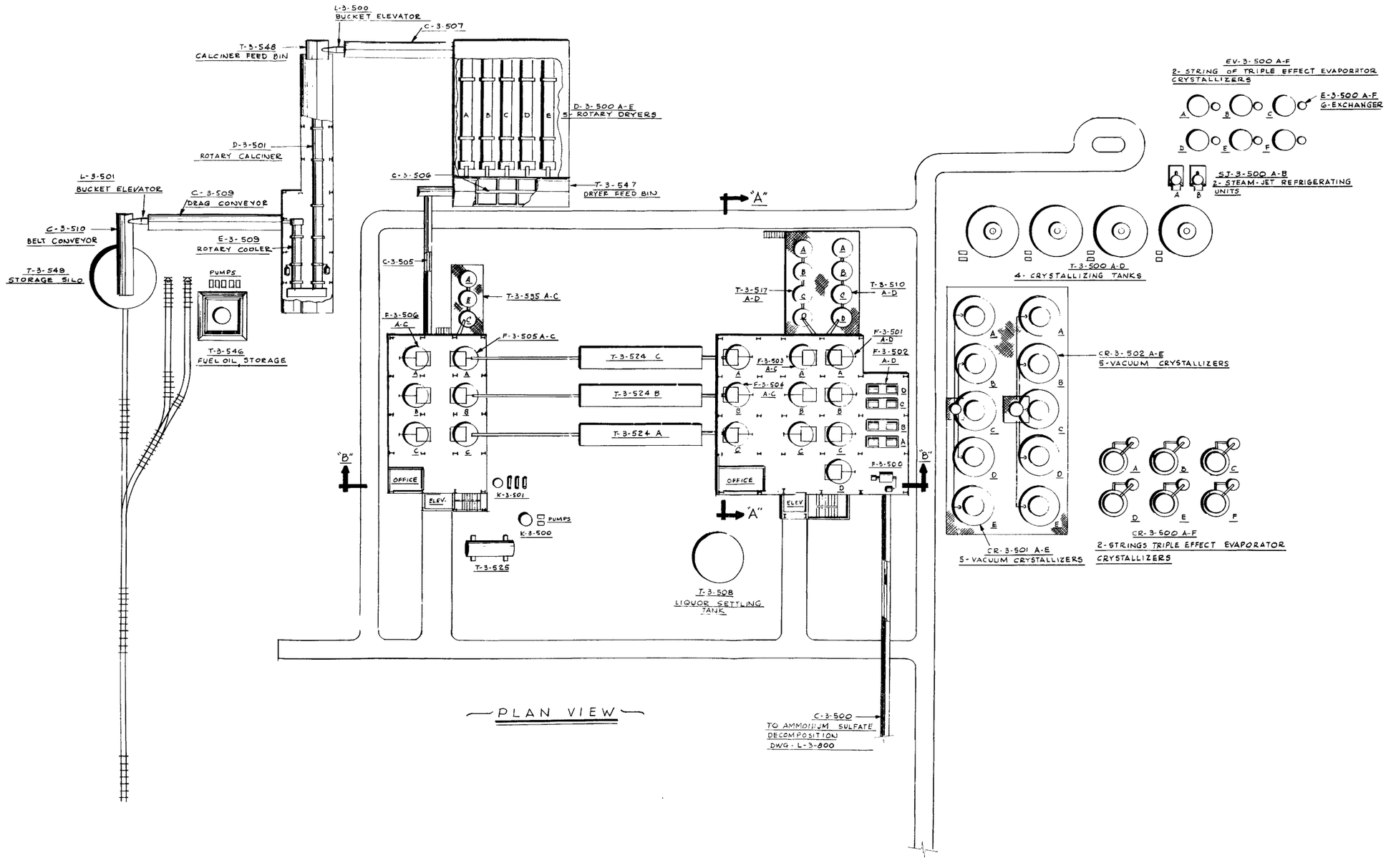
T-3-549
STORAGE SILO
1-WEEK TOTAL STORAGE CAP.
40' DIA. x 60' HIGH.

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE	DATE	LOCATION OF JOB
											DRAWN BY E.D.P.	6-16-53	
											CHECKED BY		
											CHECKED BY		

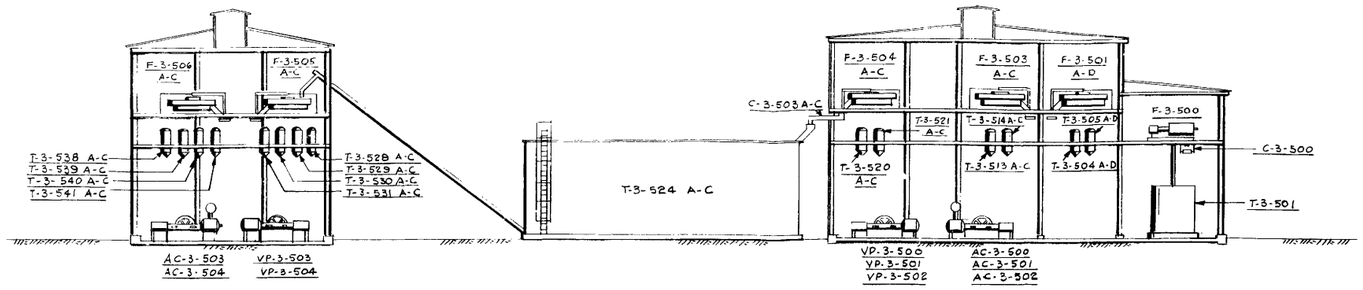
INTERNATIONAL MINERALS & CHEMICAL CORPORATION
ADDRESS MULBERRY, FLORIDA
DIVISION RESEARCH

TITLE
PROCESS FLOW DIAGRAM
ALUMINA RECOVERY
100 TON UNIT
SHEET 5 OF 5

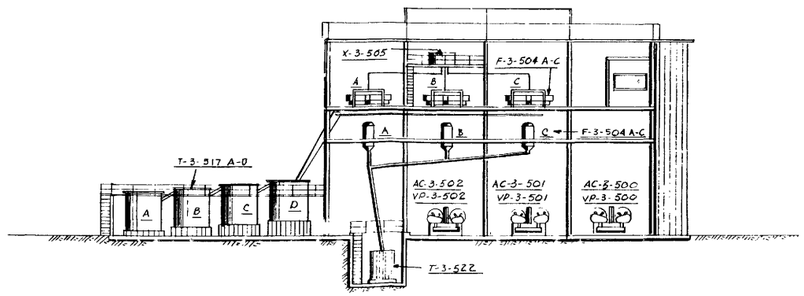
APPN. NO.
DRWG. NO. E-3-504
FILE NO.



REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE	DATE	LOCATION OF JOB	INTERNATIONAL MINERALS & CHEMICAL CORPORATION	TITLE	APPR. NO.
F-3-500 TO F-3-504 FLOW DIAGRAM SHEETS 1 TO 5											DRAWN BY H.D.K.	6-24-55		ADDRESS MULBERRY, FLORIDA	LAYOUT ALUMINA RECOVERY 100 TON UNIT	DRWG. NO. L-3-500
											CHECKED BY			DIVISION RESEARCH		FILE NO.
											CHECKED BY					



SECTION "B-B"



SECTION "A-A"

REFERENCE DRAWINGS	MARK	REVISION	BY	DATE	MARK	REVISION	BY	DATE	APPROVED BY	DATE	SCALE 0 5 10 15 20 FT	DATE	LOCATION OF JOB	INTERNATIONAL MINERALS & CHEMICAL CORPORATION	TITLE	APPR. NO.
L-3-500 LAYOUT											DRAWN BY H.D.R.	6-23-53		ADDRESS MULBERRY, FLORIDA	SECTIONS ALUMINA RECOVERY 225 TON UNIT	DRWG. NO. L-3-501
											CHECKED BY			DIVISION RESEARCH		FILE NO.
											CHECKED BY					

IV. ECONOMIC EVALUATION

A. DETAILED CAPITAL COST ESTIMATE

Detailed analyses of the capital cost estimates for the Alumina Recovery Section of the three different size plants follow. Estimates include cost of equipment, buildings and construction fees.

1. ALUMINA RECOVERY SECTION--450 Ton Unit

a. Process Equipment--

Item No.	No. Items	Description	Installed Cost
A-1-510A-H	8	Agitators, 25 hp.	$ 42,820
A-1-517A-H	8	Agitators, 25 hp.	42,820
A-1-535A-F	6	Agitators, 15 hp.	27,080
AC-1-500	1	Air compressor, 6000 cfm, 750 hp.	87,000
AC-1-501	1	Air compressor, 6000 cfm, 750 hp.	87,000
AC-1-502	1	Air compressor, 6000 cfm, 750 hp.	87,000
AC-1-503	1	Air compressor, 6000 cfm, 750 hp.	87,000
AC-1-504	1	Air compressor, 4000 cfm, 500 hp.	60,400
C-1-500	1	Weigh conveyor belt, 18"x 300', 5 hp.	35,850
C-1-501	1	Belt conveyor, 36" x 200', 10 hp.	20,755
C-1-502	1	Belt conveyor, 36" x 200'	20,755
C-1-503A-M	13	Screw Conveyors, 24" x 30', 10 hp.	115,650
C-1-504	1	Belt conveyor, 30" x 200', 10 hp.	19,550
C-1-505	1	Belt conveyor, 30" x 200', 10 hp.	19,550
C-1-506	1	Belt conveyor, 30" x 350', 15 hp.	66,250
C-1-508	1	Belt conveyor, 24" x 25', 5 hp.	4,840
C-1-507	1	Belt conveyor, 24" x 400', 10 hp.	28,650
C-1-510	1	Belt conveyor, 18" x 250', 5 hp.	40,110
C-1-509	1	Belt conveyor, 18" x 140', 5 hp.	8,840
CR-1-500A-L	12	Crystallizers, 26' dia.	4,406,500
E-1-501A-L	12	Heat Exchangers	
P-1-509 A-O	15	Circulating Pumps	
P-1-510 A-O	15	Slurry Pumps	
CR-1-501A-T	20	Vacuum crystallizers, 26' dia.	4,027,000
CR-1-502A-V	22	Vacuum crystallizers, 26' dia.	4,429,700
D-1-500 A-X	24	Rotary Dryers, 8' dia. x 80'	5,040,000
DC-1-500A-X	24	Dust collectors,	792,000
B-1-500A-X	24	Centrifugal blowers, 200 hp.	650,400
D-1-501	1	Rotary calciner, 10' dia. x 300', 75 hp.	529,320
DC-1-501	1	Dust collectors	31,000
B-1-502	1	Fan, 300 hp.	25,800

a. Process Equipment --450 Ton Unit --Continued

Item No.	No. Items	Description	Installed Cost
E-2-509	1	Rotary Cooler, 9'9"x 70', 100 hp.	$ 181,860
B-1-501A-B	2	Blowers, 40 hp.	18,130
E-1-500A-F	6	Exchangers, 11,050 s. f.	414,600
E-1-502A-D	4	Cooling coils, 21,000 s. f.	90,000
E-1-503A-D	4	Heating coils, 6,200 s. f.	29,000
E-1-504A-D	4	Steam coils, 1,655 s. f.	8,500
E-1-505	1	Condenser, 3,400 s. f.	13,500
E-1-506	1	Reboiler, 12,300 s. f.	46,400
E-1-507	1	Cooler, 13,200 s. f.	48,400
E-1-508A-B	2	Suction heaters, 400 s. f.	3,100
EV-1-500A-F	6	Evaporators, 26' dia. x 20'	853,600
F-1-500A-C	3	Centrifuges, 178 tph, 100 hp.	111,240
F-1-501A-P	16	Horizontal filters, 15' dia., 3 hp.	765,320
F-1-502A-J	10	Polishing filters, 1304 s. f.	340,000
F-1-503A-M	13	Horizontal filters, 15' dia., 3 hp.	621,822
F-1-504A-M	13	Horizontal filters, 15' dia., 3 hp.	621,822
F-1-505A-M	13	Horizontal filters, 15' dia., 3 hp.	621,822
F-1-506A-J	10	Horizontal Filters, 15'dia., 3 hp.	482,585
K-1-500	1	Ammonia absorption column, 13'6x50'	41,200
K-1-501	1	Ammonia stripping column, 7' x 50'	20,240
L-1-500	1	Bucket elevator, 81.5 tph, 10 hp.	9,350
L-1-501	1	Bucket elevator, 46.8 tph, 10 hp.	9,350
P-1-500A-D	4	Pumps, 37,500 gpm, 400 hp.	206,000
P-1-501A-D	4	Pumps, 33,500 gpm, 350 hp.	202,000
P-1-502A-D	4	Pumps, 29,800 gpm, 325 hp.	202,000
P-1-503A-C	3	Pumps, 11,250 gpm, 225 hp.	80,400
P-1-504A-C	3	Pumps, 1445 gpm, 50 hp.	20,780
P-1-505A-C	3	Pumps, 13,500 gpm, 275 hp.	80,400
P-1-506A-F	6	Pumps, 2890 gpm, 60 hp.	57,160
P-1-507A-B	2	Pumps, 2995 gpm, 100 hp.	25,920
P-1-511A-E	5	Pumps, 12,800 gpm, 250 hp.	133,000
P-1-508A-E	5	Pumps, 845 gpm, 20 hp.	19,800
P-1-512A-C	3	Pumps, 840 gpm, 25 hp.	12,540
P-1-513A-C	3	Pumps, 740 gpm, 20 hp.	12,390
P-1-514A-B	2	Pumps, 105 gpm, 5 hp.	5,370
P-1-516A-B	2	Pumps, 4706 gpm, 125 hp.	34,500
P-1-517A-U	21	Pumps, 7580 gpm, 100 hp.	305,700
P-1-515A-B	2	Pumps, 4706 gpm, 300 hp.	56,000

a. Process Equipment -- 450 Ton Unit--Continued

Item No.	No. Items	Description	Installed Cost
P-1-518A-U	21	Pumps, 212 gpm, 10 hp.	$ 59,925
P-1-519A-F	6	Pumps, 18,750 gpm, 350 hp.	177,000
P-1-520A-C	3	Pumps, 1485 gpm, 50 hp.	20,780
P-1-521A-C	3	Pumps, 760 gpm, 20 hp.	12,390
P-1-522A-B	2	Pumps, 5106 gpm, 150 hp.	37,600
P-1-523A-W	23	Pumps, 8000 gpm, 125 hp.	397,900
P-1-524A-W	23	Pumps, 212 gpm, 10 hp.	65,675
P-1-525A-F	5	Pumps, 19,150 gpm, 375 hp.	150,000
P-1-526A-C	3	Pumps, 1685 gpm, 50 hp.	20,780
P-1-527A-C	3	Pumps, 719 gpm, 20 hp.	11,490
P-1-528A-N	14	Pumps, 200 gpm, 5 hp.	23,590
P-1-529	1	Pump, 1000 gpm, 25 hp.	2,730
P-1-530A-B	2	Pumps, 1660 gpm, 30 hp.	7,380
P-1-531A-C	3	Pumps, 2035 gpm, 50 hp.	22,080
P-1-532A-C	3	Pumps, 1160 gpm, 30 hp.	17,100
P-1-533A-C	3	Pumps, 1160 gpm, 30 hp.	17,100
P-1-534A-B	2	Pumps, 3549 gpm, 75 hp.	22,040
P-1-535A-C	3	Pumps, 1200 gpm, 30 hp.	17,100
P-1-536A-C	3	Pumps, 1200 gpm, 30 hp.	17,100
P-1-537A-C	3	Pumps, 1190 gpm, 30 hp.	17,100
P-1-538A-C	3	Pumps, 1180 gpm, 30 hp.	17,100
P-1-539A-B	2	Pumps, 3760 gpm, 150 hp.	27,700
P-1-540	1	Pump, 500 gpm, 25 hp.	2,430
P-1-541A-I	9	Pumps, 13 gpm, 1 hp.	12,420
P-1-542A-B	2	Pumps, 1576 gpm, 100 hp.	21,520
SJ-1-500A-B	2	Steam Jet Refrigeration Units, 2400 tons	349,000
SJ-1-501A-T	20	Steam Jet Refrigeration Units, 860 tons	1,410,000
SJ-1-502A-V	22	Steam Jet Refrigeration Units, 800 tons	1,477,000
T-1-500A-D	4	Crystallizers, 250,000 gals.	590,000
R-1-500A-D	4	Rake mechanisms, 50' dia., 15 hp.	64,120
T-1-501	1	Feed Tank, 60,000 gals,	46,200
T-1-502	1	Compressed air receiver 5'6 x 18'	2,050
T-1-503	1	Vacuum scrubber, 9' x 20'	3,900
T-1-504 A-P	16	Filtrate Receivers, 117 gals.	19,200
T-1-505A-P	16	Wash Receivers, 117 gals.	19,200
T-1-506A-B	2	Filtrate Surge Tanks, 5000 gals.	9,400
T-1-507A-B	2	Wash Liquor Surge Tanks, 5000 gals.	9,400
T-1-508	1	Settling Tank, 500,000 gals.	179,000

a. Process Equipment---450 Ton Unit---Continued

Item No.	No. Items	Description	Installed Cost
R-1-508	1	Rake mechanism, 25 hp.	$ 16,740
T-1-509	1	Filtrate surge tank, 28,000 gals.	26,040
T-1-510A-D	4	Alum Redissolving tanks, 50,000 gals.	156,400
T-1-511	1	Compressed Air Receiver, 5'6" x 18'	2,050
T-1-512	1	Vacuum Scrubber, 9' dia. x 20 '	3,900
T-1-513	1	Filtrate Receivers, 275 gals.	40,700
T-1-514	1	Wash Receivers, 140 gals.	16,200
T-1-515A-B	2	Filtrate Surge Tank, 9000 gals.	15,600
T-1-516A-B	2	Wash Liquor Surge Tank, 4500 gals.	9,400
T-1-517A-D	4	Alum Resolution Tanks, 46,000 gals.	158,600
T-1-518	1	Compressed Air Tank, 5'6 x 18'	2,050
T-1-519	1	Vacuum scrubber, 9' dia. x 20'	3,900
T-1-520A-M	13	Filtrate Receivers, 315 gals.	41,700
T-1-521A-M	13	Wash Liquor Receivers, 132 gals.	16,200
T-1-522A-B	2	Filtrate Surge Tank, 10,000 gals.	15,200
T-1-523A-B	2	Wash Liquor Surge Tank, 4,300 gals.	9,200
T-1-524A-M	13	Precipitation Tanks, 12' w x 85' lg. x 30' deep	5,074,050
T-1-525A-B	2	Liquid NH_3 Storage Tanks, 76,000 gals.	97,000
T-1-526	1	Compressed Air Tank, 5'6 dia. x 18'	2,050
T-1-527	1	Vacuum Scrubber, 9' dia. x 20'	3,900
T-1-528A-M	13	Filtrate Receivers, 2'6 x 5'	16,300
T-1-529A-M	13	Filtrate Receivers, 2'6 x 6'	17,600
T-1-530A-M	13	Wash Receivers, 2'6 x 6'	17,600
T-1-531A-M	13	Wash Receivers, 2'6" x 6'	17,600
T-1-532A-B	2	Filtrate Surge Tanks, 12,200 gals.	18,200
T-1-533A-B	2	Wash Surge Tanks, 7000 gals.	12,200
T-1-534A-B	2	Wash Surge Tanks, 7000 gals.	12,200
T-1-535A-C	3	Repulping Tanks, 21,300 gals.	87,000
T-1-536 A-C	3	Compressed Air Surge Tank, 5'6" x 18'	2,050
T-1-537	1	Vacuum Scrubber, 9' x 20'	3,900
T-1-538 A-J	10	Filtrate Receivers, 285 gals.	30,700
T-1-539A-J	10	Wash Receivers, 285 gals.	30,700
T-1-540A-J	10	Wash Receivers, 285 gals.	30,700
T-1-541A-J	10	Wash Receivers, 285 gal.	30,700
T-1-542A-B	2	Filtrate Surge Tanks, 7000 gals.	12,200
T-1-543A-B	2	Wash Surge Tank, 7000 gals.	12,200
T-1-544A-B	2	Wash Surge Tank, 7000 gals.	12,200
T-1-545A-B	2	Wash Surge Tank, 7000 gals.	12,200
T-1-546	1	Fuel Oil Storage Tank, 60,000 gals.	9,200
T-1-547	1	Dryer Feed Bin & Feeders,15' w x 20' x360' lg.	295,200

a. Process Equipment -- 450 Ton Unit -- Continued

Item No.	No. Items	Description	Installed Cost
T-1-548	1	Calciner Feed Bin,14' w x 14' d x 14' lg.	$ 21,600
T-1-549A-F	6	Storage Silos, 30' dia. x 75' high	553,800
VP-1-500	1	Vacuum pump, 40,000 cfm, 1500 hp.	120,750
VP-1-501	1	Vacuum pump, 40,000 cfm, 1500 hp.	120,750
VP-1-502	1	Vacuum pump, 40,000 cfm, 1500 hp.	120,750
VP-1-503	1	Vacuum pump, 40,000 cfm, 1500 hp.	120,750
VP-1-504	1	Vacuum pump, 30,000 cfm, 1250 hp.	104,200
X-1-500A-B	2	Slurry Distributors, 35000 gals,	21,400
X-1-501A-B	2	Wash Liquor Distributors, 1800 gals.	13,200
X-1-502A-B	2	Slurry Distributors, 5150 gals.	24,400
X-1-503A-B	2	Wash Liquor Distributor, 1820 gals.	13,200
X-1-515A-B	2	Liquor Distributors, 2825 gals.	9,700
X-1-504A-B	2	Distributors, 6250 gals.	25,400
X-1-505A-B	2	Distributors, 5600 gals.	24,400
X-1-506A-B	2	Wash Liquor Distributors, 1725 gals.	13,200
X-1-507A-B	2	Slurry Distributors, 3450 gals.	16,400
X-1-508A-B	2	Wash Liquor Distributors, 2800 gals.	14,400
X-1-509A-B	2	Wash Liquor Distributors, 2800 gals.	14,400
X-1-510A-B	2	Wash Liquor Distributors, 2800 gals.	14,400
X-1-511A-B	2	Slurry Distributors, 4250 gals.	18,400
X-1-512A-B	2	Wash Liquor Distributors, 2850 gals.	15,400
X-1-513A-B	2	Wash Liquor Distributors, 2850 gals.	15,400
X-1-514A-B	2	Water Wash Distributors, 2850 gals.	15,400
		Piping, Valves, & Fittings	6,915,000
		Hangers,	100,000
		Insulation	35,000
		Lighting, Yard Units	60,000
		Painting	90,000
		Power Centers	240,000
		Instruments & Controls	1,000,000
		SUB TOTAL	$49,279,171

b. Structures -- 450 Ton Unit

Calciner & Rotary Cooler Building, (30' w x 360' x 40') (15' w x 120' x 40')	$ 217,000
Rotary Dryer Building, 120' w x 330' lg x 40' high	681,000
Filter Building, 60' w x 330' lg. x 60' high	510,000
Filter Building, 90' w x 520' lg. x 60'high 30' w x 200' lg. x 44' high	1,322,000
SUB TOTAL	$ 2,730,000

c. Engineering & Construction Costs--450 Ton Unit

Construction Supplies, 4% of labor	$ 261,000
Insurance & Taxes, 8% of labor	522,000
Supervision & Field Office, 12% of labor	783,000
Use of Construction Equipment and Temporary Construction 5% of labor	326,000
Engineering & Drafting) Process Engineering) Engineering Administration)	4,000,000
Purchasing, Inspection & Expediting	500,000
Contingency, 10%	5,840,117
Engineering--Contractor Fee, 4%	2,336,712
SUB TOTAL	$ 14,568,829

450 TON UNIT CAPITAL COST ESTIMATE TOTAL $ 66,578,000

IV. ECONOMIC EVALUATION

A. DETAILED CAPITAL COST ESTIMATE

1. ALUMINA RECOVERY SECTION -- 225 Ton Unit

a. Process Equipment --

Item No.	No. Items	Description	Installed Cost
A-2-510 A-H	8	Agitators, 15 hp.	$ 36,140
A-2-517A-H	8	Agitators, 15 hp.	36,140
A-2-535A-F	6	Agitators, 7.5 hp.	20,430
AC-2-500	1	Air compressor, 3000 cfm, 375 hp.	54,600
AC-2-501	1	Air compressor, 3000 cfm, 375 hp.	54,600
AC-2-502	1	Air compressor, 3000 cfm, 375 hp.	54,600
AC-2-503	1	Air compressor, 3000 cfm, 375 hp.	54,600
AC-2-504	1	Air compressor, 2000 cfm, 250 hp.	46,500
C-2-500	1	Weight conveyor belt, 18" x 300'	35,850
C-2-501	1	Belt conveyor, 24" x 200'	16,050
C-2-502	1	Belt conveyor, 24" x 200 '	16,050
C-2-503A-G	7	Screw conveyors, 24" x 20'	55,150
C-2-504	1	Belt conveyor, 24" x 200'	15,540
C-2-505	1	Belt conveyor, 24" x 200'	15,540
C-2-506	1	Belt conveyor, 24" x 160'	17,140
C-2-507	1	Belt conveyor, 20" x 400'	26,140
C-2-508	1	Belt conveyor, 24" x 20'	4,540
C-2-509	1	Drag conveyor, 14" x 140'	7,340
C-2-510	1	Belt conveyor, 14" x 125'	21,480
CR-2-500A-F	6	(Crystallizers, 26' dia.)	
E-2-501A-F	6	(Heat Exchangers)	2,203,250
P-2-509A-I	9	(Circulating Pumps,)	
P-2-510A-I	9	(Slurry Pumps)	
CR-2-501 A-J	10	Vacuum crystallizers, 26' dia.	2,008,500
CR-2-502A-K	11	Vacuum crystallizers, 26' dia.	2,225,600
D-2-500A-L	12	Rotary Dryers, 8' x 80'	2,520,000
D-C-2-500A-L	12	Dust collectors, 12 cyclones	396,000
B-2-500A-L	12	Centrifugal blowers, 200 hp.	325,200
D-2-501	1	Calciner, 8'6" dia, x 250', 40 hp.	387,280
DC-2-501	1	Dust Collector, 12 cyclones	24,000
B-2-502	1	Fan, 250 hp.	23,700
E-2-509	1	Rotary cooler, 50 hp.	112,060

a. Process Equipment -- 225 Ton Unit -- continued

Item No.	No. Items	Description	Installed Cost
B-2-501A-B	2	Blowers, 20 hp.	$ 11,430
E-2-500A-F	6	Heat exchangers, 5,525 s.f.	207,300
E-2-502A-D	4	Cooling coils, 10,500 s.f.	45,000
E-2-503A-D	4	Heating coils, 3100 s.f.	15,500
E-2-504A-D	4	Steam coils, 838 s.f.	5,200
E-2-505	1	Condenser, 1700 s.f.	7,400
E-1-506	1	Reboiler, steam, 6150 s.f.	24,000
E-2-507	1	Cooler, 6600 s.f.	25,000
E-2-508	1	Fuel oil suction heater, 400 s.f.	1,300
EV-2-500A-C	3	Evaporators, 26' dia.	428,800
F-2-500A-B	2	Continuous centrifuges, 89 tph, 50 hp.	57,920
F-2-501A-H	8	Horizontal filters, 15' dia., 3 hp.	382,660
F-2-502A-E	6	Polishing filters, 1304 s.f.	204,000
F-2-503A-G	7	Horizontal filters, 15' dia., 3 hp.	334,830
F-2-504A-G	7	Horizontal filters, 15' dia., 3 hp.	334,830
F-2-505A-G	7	Horizontal filters, 15' dia., 3 hp.	334,830
F-2-506A-E	5	Horizontal filters, 15' dia., 3 hp.	239,160
K-2-500	1	Ammonia absorption column, 9'6"x50'	24,220
K-2-501	1	Ammonia stripping column, 5' x 50'	11,585
L-2-500	1	Bucket elevator, 40.8 tph, 5 hp.	5,840
L-2-501	1	Bucket elevator, 23.4 tph, 5 hp.	8,240
P-2-500A-C	3	Pumps, 18,750 gpm, 200 hp.	122,300
P-2-501A-C	3	Pumps, 16,750 gpm, 200 hp.	104,300
P-2-502A-C	3	Pumps, 14,900 gpm, 175 hp.	104,300
P-2-503A-C	3	Pumps, 5625 gpm, 125 hp.	39,250
P-2-504A-C	3	Pumps, 723 gpm, 25 hp.	10,740
P-2-505A-C	3	Pumps, 6175 gpm, 150 hp.	41,700
P-2-506A-F	6	Pumps, 1445 gpm, 30 hp.	36,540
P-2-507A-B	2	Pumps, 1498 gpm, 50 hp.	14,120
P-2-508A-C	3	Pumps, 845 gpm, 20 hp.	12,000
P-2-511A-C	3	Pumps, 12,800 gpm, 250 hp.	80,400
P-2-512A-B	2	Pumps, 840 gpm, 25 hp.	8,460
P-2-513A-B	2	Pumps, 740 gpm, 20 hp.	8,350
P-2-514A-B	2	Pumps, 53 gpm, 3 hp.	5,370
P-2-515A-B	2	Pumps, 2353 gpm, 150 hp.	27,140
P-2-516A-B	2	Pumps, 2353 gpm, 60 hp.	15,160
P-2-517A-K	11	Pumps, 7580 gpm, 100 hp.	160,160
P-2-518A-K	11	Pumps, 212 gpm, 10 hp.	31,405

a. Process Equipment -- 225 Ton Unit -- Continued

Item No.	No. Items	Description	Installed Cost
P-2-519A-C	3	Pumps, 23,450 gpm, 450 hp.	$ 91,500
P-2-520A-B	2	Pumps, 1485 gpm, 50 hp.	13,920
P-2-521A-B	2	Pumps, 760 gpm, 20 hp.	8,360
P-2-522A-B	2	Pumps, 2552 gpm, 75 hp.	21,420
P-2-523A-L	12	Pumps, 8000 gpm, 125 hp.	207,600
P-2-524A-L	12	Pumps, 212 gpm, 10 hp.	34,260
P-2-525A-D	4	Pumps, 15,950 gpm, 350 hp.	116,000
P-2-526A-B	2	Pumps, 1685 gpm, 50 hp.	13,920
P-2-527A-B	2	Pumps, 719 gpm, 20 hp.	7,660
P-2-528A-H	8	Pumps, 200 gpm, 5 hp.	13,440
P-2-529	1	Pump , 500 gpm, 15 hp.	2,160
P-2-530A-B	2	Pumps, 830 gpm, 15 hp.	4,720
P-2-531A-B	2	Pumps, 2062 gpm, 50 hp.	14,720
P-2-532A-B	2	Pumps, 1160 gpm, 30 hp.	11,400
P-2-533A-B	2	Pumps, 1160 gpm, 30 hp.	11,400
P-2-534A-B	2	Pumps, 1774 gpm, 50 hp.	13,840
P-2-535A-B	2	Pumps, 1153 gpm, 30 hp.	11,400
P-2-536A-B	2	Pumps, 1200 gpm, 30 hp.	11,400
P-2-537A-B	2	Pumps, 1190 gpm, 30 hp.	11,400
P-2-538A-B	2	Pumps, 1180 gpm, 30 hp.	11,400
P-2-539A-B	2	Pumps, 1880 gpm, 75 hp.	18,220
P-2-540	1	Pump, 250 gpm, 15 hp.	2,000
P-2-541A-E	5	Rotary gear pumps, 14 gpm, 1 hp.	6,350
P-2-542A-B	2	Pumps, 788 gpm, 50 hp.	10,520
SJ-2-500A-B	2	Steam Jet Refrigeration Unit, 1200 tons	174,500
SJ-2-501A-J	10	Steam Jet Refrigeration Unit, 860 tons	705,000
SJ-2-502A-K	11	Steam Jet Refrigeration Unit, 800 tons	738,500
T-2-500A-D	4	Crystallizers, 125,000 gals.	378,600
R-2-500A-D	4	Rake mechanisms, 40' dia.	53,900
T-2-501	1	Crystallizers, 30,000 gals.	30,800
T-2-502	1	Compressed air receiver, 4' x 17'	1,600
T-2-503	1	Vacuum scrubber, 7'6" x 15'	2,600
T-2-504A-H	8	Filtrate receivers, 117 gals.	9,600
T-2-505A-H	8	Wash receivers, 90 gals.	9,600
T-2-506	1	Surge tank, 5000 gals.	4,700
T-2-507	1	Wash liquor surge tank, 5000 gals.	4,700
T-2-508	1	Surge & Settling tank, 250,000 gals.	119,000

a. Process Equipment -- 225 Ton Unit --- Continued

Item No.	No. Items	Description	Installed Cost
R-2-508	1	Rake mechanism, 40' dia, 15 hp.	$ 11,970
T-2-509	1	Filtrate Surge tank, 14,000 gals.	16,640
T-2-510A-D	4	Alum Redissolving tanks, 25,000 gals.	108,600
T-2-511	1	Compressed air receiver, 4' x17'	1,600
T-2-512	1	Vacuum scrubber, 7'6" x 15'	2,600
T-2-513A-G	7	Filtrate receivers, 275 gals.	21,700
T-2-514A-G	7	Wash receivers, 140 gals.	9,100
T-2-515	1	Filtrate surge tank, 9000 gals.	7,600
T-2-516	1	Wash liquor surge tank, 4500 gals.	4,700
T-2-517A-D	4	Alum resolution tanks, 23,000 gals.	102,000
T-2-518	1	Compressed air, 4' x 17'	1,600
T-2-519	1	Vacuum scrubber, 7'6" x 15'	2,600
T-2-520A-G	7	Filtrate receivers, 315 gals.	22,400
T-2-521A-G	7	Wash liquor receivers, 132 gals.	8,800
T-2-522	1	Filtrate surge tank, 10,000 gals.	7,600
T-2-523	1	Wash liquor surge tank, 4,300 gals.	4,600
T-2-524A-G	7	Precipitation tanks, 12' x 85' x 30'	2,729,680
T-2-525	1	Liquid NH_3 storage tank, 76000 gals.	97,000
T-2-526	1	Compressed air surge tank, 4' x 17'	1,600
T-2-527	1	Vacuum scrubber, 7'6" x 15'	2,600
T-2-528A-G	7	Filtrate receivers, 170 gals.	8,400
T-2-529A-G	7	Wash receivers, 215 gals.	9,100
T-2-530A-G	7	Wash receivers, 215 gals.	9,100
T-2-531A-G	7	Wash receivers, 215 gals.	9,100
T-2-532	1	Filtrate surge tank, 12,200 gals.	9,100
T-2-533	1	Wash surge tank, 7,000 gals.	6,100
T-2-534	1	Wash surge tank, 7,000 gals.	6,100
T-2-535A-C	3	Repulping tanks, 10,650 gals.	76,000
T-2-536	1	Compressed air surge tank, 4' x 17'	1,600
T-2-537	1	Vacuum scrubber, 7'6" x 15'	2,600
T-2-538A-E	5	Filtrate receivers, 285 gals.	15,350
T-2-539A-E	5	Wash receivers, 285 gals.	15,350
T-2-540A-E	5	Wash receivers, 285 gals.	15,350
T-2-541A-E	5	Wash receivers, 285 gals.	15,350
T-2-542	1	Filtrate surge tank, 7,000 gals.	6,100
T-2-543	1	Wash surge tank, 7,000 gals.	6,100

a. Process Equipment -- 225 Ton Unit -- Continued

Item No.	No. Items	Description	Installed Cost
T-2-544	1	Wash surge tank, 7000 gals.	$ 6,100
T-2-545	1	Wash surge tank, 7000 gals.	6,100
T-2-546	1	Fuel oil storage tank, 30,000 gals.	5,900
T-2-547	1	Dryer feed bin, 15' x 20' x 180'	193,000
T-2-548	1	Calciner feed bin, 10' x 11' x 13'	13,300
T-2-549A-C	3	Storage silos, 30' x 75'	284,000
VP-2-500	1	Vacuum pump, 20,000 cfm, 750 hp.	77,200
VP-2-501	1	Vacuum pump, 20,000 cfm, 750 hp.	77,200
VP-2-502	1	Vacuum pump, 20,000 cfm, 750 hp.	77,200
VP-2-503	1	Vacuum pump, 20,000 cfm, 750 hp.	77,200
VP-504	1	Vacuum pump, 15,000 cfm, 560 hp.	65,600
X-2-500	1	Slurry distributor, 3500 gals.	10,700
X-2-501	1	Wash liquor distributor, 1800 gal.	6,600
X-2-502	1	Slurry distributor, 5150 gals.	12,200
X-2-503	1	Wash liquor distributor, 1820 gals.	6,600
X-2-515	1	Liquor distributor, 2825 gals.	9,700
X-2-504	1	Distributor, 6250 gals.	12,700
X-2-505	1	Slurry distributor, 5600 gals.	12,200
X-2-506	1	Wash liquor distributor, 1725 gals.	6,600
X-2-507	1	Slurry distributor, 3450 gals.	8,200
X-2-508	1	Wash liquor distributor, 2800 gals.	7,200
X-2-509	1	Wash liquor distributor, 2800 gals.	7,200
X-2-510	1	Filtrate wash liquor distributor, 2800 gals.	7,200
X-2-511	1	Slurry distributor, 4250 gals.	9,200
X-2-512	1	Wash liquor distributor, 2850 gals.	7,700
X-2-513	1	Wash liquor distributor, 2850 gals.	7,700
X-2-514	1	Water wash distributor, 2850 gals.	7,700
		Piping, valves & fittings	4,200,000
		Hangers,	65,000
		Pipe Insulation	22,000
		Lighting, Yard Units	40,000
		Painting	60,000
		Power Centers	170,000
		Instruments & Controls	690,000
		SUB TOTAL	$ 26,891,860

b. Structures -- 225 Ton Unit

Rotary Dryer Bldg., 72' x 180' x 40' high	$ 222,000
Rotary Calciner Bldg., 30' x 270' x 40' high 15' x 90' x 40' high	118,000
Filter Bldg. 60' x 210' x 60' high	325,000
Filter Bldg. 90' x 240' x 60' high 30' x 135' x 44' high	634,000
SUB TOTAL	$ 1,299,000

C. Engineering & Construction Costs

Construction Supplies, 4% of Labor	$ 148,922
Insurance & Taxes , 8% of Labor	297,844
Supervision & Field Office, 12% of Labor	446,766
Use of Construction Equipment and Temporary Construction, 5% of Labor	136,103
Engineering & Drafting Process Engineering Engineering administration	3,550,000
Purchasing, Expediting & Inspection	290,000
Contingency 10% of Total	3,306,049
Engineering- Contractor Fee 4% of Total	1,322,456
SUB TOTAL	$ 9,498,140

225 Ton Unit----CAPITAL COST ESTIMATE TOTAL $ 37,689,000

IV. ECONOMIC EVALUATION

A. DETAILED CAPITAL COST ESTIMATE

1. ALUMINA RECOVERY SECTION--100 Ton Unit

a. Process Equipment--

Item No.	No. Items	Description	Installed Cost
A-3-510A-H	8	Agitators, 5 hp.	24,190
A-3-517A-H	8	Agitators, 7 1/2 hp.	27,240
A-3-535A-F	8	Agitators, 3 hp.	16,110
AC-3-500	1	Air compressor, 1330 cfm, 175 hp.	17,220
AC-3-501	1	Air compressor, 1330 cfm, 175 hp.	17,220
AC-3-502	1	Air compressor, 1330 cfm, 175 hp.	17,220
AC-3-503	1	Air compressor, 1330 cfm, 175 hp.	17,220
AC-3-504	1	Air compressor, 880 cfm, 125 hp.	13,100
C-3-500	1	Conveyor belt, 12" w x 300', 2 hp.	32,405
C-3-501	1	Belt conveyor, 20" x 200', 3 hp.	15,940
C-3-502	1	Belt conveyor, 20" x 200', 3 hp.	15,940
C-3-503A-C	3	Screw conveyors, 24'' x 20', 10 hp.	23,850
C-3-504	1	Belt conveyor, 18" x 200', 3 hp.	12,540
C-3-505	1	Belt conveyor, 18" x 200', 3 hp.	12,540
C-3-506	1	Belt conveyor, 16" x 75', 5 hp.	9,060
C-3-507	1	Belt conveyor, 12" x 130', 2 hp.	8,370
C-3-508	1	Belt conveyor, 12" x 20', 1 1/2 hp.	3,595
C-3-509	1	Drag conveyor, 12" x 250', 3 hp.	10,140
C-3-510	1	Belt conveyor, 12" x 30' , 1 hp.	6,570
CR-3-500A-F	6	(Crystallizers, 17'4" dia.)	
E-3-501A-F	6	(Heat Exchangers)	1,030,000
P-3-509A-I	9	(Circulating Pumps)	
P-3-510A-I	9	(Slurry Pumps)	
CR-3-501A-E	5	Vacuum crystallizers, 26' dia.	1,010,000
CR-3-502A-E	5	Vacuum crystallizers, 26' dia.	1,010,000
D-3-500A-E	5	Rotary Dryers, 8' dia. x 80', 200 hp.	1,050,550
DC-3-500A-E	5	Dust collectors, 12 per dryer	165,000
B-3-500A-E	5	Centrifugal blowers, 200 hp.	135,500
D-3-501	1	Rotary calciner, 6' dia. x 150' lg.	219,100
DC-3-501	1	Dust collectors,	13,000
B-3-502	1	Fan, 125 hp.	13,400

a. Process Equipment -- 100 Ton Unit -- Continued

Item No.	No. Items	Description	Installed Cost
E-3-509	1	Rotary cooler, 7' dia. x 50 lg, 25 hp.	$ 81,740
B-3-501A-B	2	Blowers, 10 hp.	9,420
E-3-500A-F	6	Heat Exchangers, 2450 s. f.	92,350
E-3-502A-D	4	Cooling coils, 4,660 s. f.	23,000
E-3-503A-D	4	Steam Coils, 1380 s. f.	7,700
E-3-504A-D	4	Steam Coils, 490 s. f.	3,400
E-3-505	1	Condenser, 755 s. f.	4,400
E-3-506	1	Reboiler, 2740 s. f.	10,850
E-3-507	1	Cooler, 2940 s. f.	12,100
E-3-508	1	Fuel oil suction heater, 180 s. f.	650
EV-3-500A-F	6	Evaporators, 12'3" dia.	286,600
F-3-500	1	Centrifuge, 39.6 tph, 50 hp.	26,960
F-3-501A-D	4	Filters, 15' dia., 3 hp.	191,330
F-3-503A-C	3	Filters, 15' dia., 3 hp.	143,505
F-3-502A-D	4	Filters, 1204 s. f.	136,000
F-3-504A-C	3	Filters, 15' dia., 3 hp.	143,505
F-3-505A-C	3	Filters, 15' dia. 3 hp.	143,505
P-3-506A-C	3	Filters, 15' dia. 3 hp.	143,505
K-3-500	1	Ammonia absorption column, 6'6"x 50'	14,300
K-3-501	1	Ammonia stripping column, 3'4" x 50'	8,010
L-3-500	1	Bucket elevator, 18.1 tph, 3 hp.	5,340
L-3-501	1	Bucket elevator, 10.4 tph, 3 hp.	7,740
P-3-500A-C	3	Pumps, 8325 gpm, 100 hp.	70,680
P-3-501A-C	3	Pumps, 7450 gpm, 100 hp.	67,680
P-3-502A-C	3	Pumps, 6600 gpm, 75 hp.	53,480
P-3-503A-C	3	Pumps, 2500 gpm, 50 hp.	20,380
P-3-504A-C	3	Pumps, 320 gpm, 15 hp.	9,940
P-3-505A-C	3	Pumps, 2750 gpm, 60 hp.	16,880
P-3-506A-F	6	Pumps, 640 gpm, 15 hp.	22,600
P-3-507A-B	2	Pumps, 665 gpm, 25 hp.	8,060
P-3-508A-B	2	Pumps, 750 gpm, 15 hp.	7,760
P-3-511A-B	2	Pumps, 11,400 gpm, 225 hp.	50,200
P-3-512A-B	2	Pumps, 374 gpm, 15 hp.	6,430
P-3-513A-B	2	Pumps, 329 gpm, 10 hp.	6,620
P-3-514A-B	2	Pumps, 23 gpm, 1 1/2 hp.	4,030
P-3-515A-B	2	Pumps, 1045 gpm, 75 hp.	15,820
P-3-516A-B	2	Pumps, 1045 gpm, 30 hp.	9,400
P-3-517A-F	6	Pumps, 7580 gpm, 100 hp.	87,460
P-3-518A-F	6	Pumps, 212 gpm, 10 hp.	17,130
P-3-519A-B	2	Pumps, 20,800 gpm, 400 hp.	57,200

a. Process Equipment -- 100 Ton Unit -- Continued

Item No.	No. Items	Description	Installed Cost
P-3-520A-B	2	Pumps, 660 gpm, 25 hp.	$ 7,860
P-3-521A-B	2	Pumps, 338 gpm, 10 hp.	6,620
P-3-522A-B	2	Pumps, 1134 gpm, 40 hp.	12,530
P-3-523A-F	6	Pumps, 8000 gpm, 125 hp.	103,800
P-3-524A-F	6	Pumps, 208 gpm, 10 hp.	17,130
P-3-525A-B	2	Pumps, 21,360 gpm, 425 hp.	61,200
P-3-526A-B	2	Pumps, 748 gpm, 25 hp.	7,560
P-3-527A-B	2	Pumps, 320 gpm, 10 hp.	5,720
P-3-528A-D	4	Pumps, 200 gpm, 5 hp.	3,370
P-3-529	1	Pump, 225 gpm, 7.5hp.	1,890
P-3-530A-B	2	Pumps, 369 gpm, 7 1/2 hp.	3,880
P-1-531A-B	2	Pumps, 915 gpm, 25 hp.	7,760
P-3-532A-B	2	Pumps, 516 gpm, 15 hp.	7,430
P-3-533A-B	2	Pumps, 516 gpm, 15 hp.	7,430
P-3-534A-B	2	Pumps, 790 gpm, 20 hp.	8,250
P-3-535A-B	2	Pumps, 512 gpm, 15 hp.	7,430
P-3-536A-B	2	Pumps, 534 gpm, 15 hp.	7,430
P-3-537A-B	2	Pumps, 530 gpm, 15 hp.	7,430
P-3-538A-B	2	Pumps, 525 gpm, 15 hp.	7,430
P-3-539A-B	2	Pumps, 835 gpm, 40 hp.	10,130
P-3-540	1	Pump, 110 gpm, 7 1/2 hp.	1,900
P-3-541A-E	5	Pumps, 6 gpm, 1/2 hp.	6,050
P-1-542A-B	2	Pumps, 351 gpm, 20 hp.	6,730
SJ-3-500A-B	2	Steam jet refrigeration units--1066 tons	101,000
SJ-3-501A-E	5	Steam jet refrigeration units--4300 tons	352,500
SJ-3-502A-E	5	Steam jet refrigeration units--4000 tons	336,000
T-3-500A-D	4	Crystallizers, 55,000 gals.	273,800
R-3-500A-D	4	Rake mechanisms for above, 32' dia.	38,260
T-3-501	1	Crystallizer feed tank, 13,320 gals.	20,560
T-3-502	1	Surge tank, 3' 6" x 10'	1,100
T-3-503	1	Vacuum scrubber, 5' dia. x 15'	2,100
T-3-504A-D	4	Filtrate receivers, 117 gals.	4,800
T-3-505A-D	4	Wash receivers, 117 gals.	4,800
T-3-506	1	Surge tank, 2220 gals.	2,800
T-3-507	1	Surge tank, 2220 gals.	2,800
T-3-508	1	Surge & settling tank, 101,000 gals.	70,200
R-3-508	1	Rake mechanism for above, 35' dia.	10,250

a. Process Equipment-- 100 Ton Unit -- Continued'

Item No.	No. Items	Description	Installed Cost
T-3-509	1	Surge Tank, 6300 gals.	$ 10,480
T-3-510A-D	4	Alum dissolving tanks, 11,100 gals.	66,400
T-3-511	1	Compressed air receiver, 3'6" x 10'	1,100
T-3-512	1	Vacuum scrubber, 5' dia. x 15'	2,100
T-3-513A-C	3	Filtrate receivers, 275 gals.	9,300
T-3-514A-C	3	Wash receivers, 140 gals.	3,900
T-3-515	1	Filtrate surge tank, 4000 gals.	4,600
T-3-516	1	Wash liquor surge tank, 2000 gals.	2,900
T-3-517A-D	4	Alum resolution tanks, 10,200 gals.	60,400
T-3-518	1	Compressed air surge tank, 3'6" x 10'	1,100
T-3-519	1	Vacuum scrubber, 5' dia. x 15'	2,100
T-3-520A-C	3	Filtrate receivers, 315 gals.	9,600
T-3-521A-C	3	Wash Liquor receivers, 132 gals.	3,900
T-3-522	1	Filtrate surge tank, 4400 gals.	4,700
T-3-523	1	Wash liquor surge tank, 1000 gals.	2,300
T-3-524A-C	3	Precipitation tanks, 12' w x85'x 30'	1,172,930
T-3-525	1	Liquid NH_3 storage tank, 17,000 gals.	17,740
T-3-526	1	Compressed air surge tank, 3'6"x 10'	1,100
T-3-527	1	Vacuum scrubber, 5' dia. x 15'	2,100
T-3-528A-C	3	Filtrate receivers, 170 gals.	3,600
T-3-529A-C	3	Wash receivers, 215 gals.	3,900
T-3-530A-C	3	Wash receivers, 215 gals.	3,900
T-3-531A-C	3	Wash receivers, 215 gals.	3,900
T-3-532	1	Filtrate surge tank, 5200 gals.	4,600
T-3-533	1	Wash surge tank, 3110 gals.	3,600
T-3-534	1	Wash surge tank, 3110 gals.	3,600
T-3-535A-C	3	Repulping tanks, 4740 gals.	35,600
T-3-536	1	Compressed air surge tank, 3'6" x 10'	1,100
T-3-537	1	Vacuum scrubber, 5' dia. x 15' high	2,100
T-3-538A-C	3	Filtrate Receivers, 285 gals.	9,600
T-3-539A-C	3	Wash receivers, 285 gals.	9,600
T-3-540A-C	3	Wash receivers, 285 gals.	9,600
T-3-541A-C	3	Wash receivers, 285 gals.	9,600
T-3-542	1	Filtrate Surge tank, 3110 gals.	3,600
T-3-543	1	Wash surge tank, 3110 gals.	3,600
T-3-544	1	Wash surge tank, 3110 gals.	3,600
T-3-545	1	Wash surge tank, 3110 gals.	3,600

a. Process Equipment -- 100 Ton Unit -- Continued

Item No.	No. Items	Description	Installed Cost
T-3-546	1	Fuel oil storage tank, 13,000 gals.	$ 3,700
T-3-547	1	Dryer feed bin, 15' x 20' x 75'	83,150
T-3-548	1	Calciner feed bin, 10'x 7' x 10'	11,510
T-3-549	1	Storage silo, 40' dia. x 60' high	102,400
VP-3-500	1	Vacuum pump, 8900 cfm, 350 hp.	49,700
VP-3-501	1	Vacuum pump, 8900 cfm, 350 hp.	49,700
VP-3-502	1	Vacuum pump, 8900 cfm, 350 hp.	49,700
VP-3-503	1	Vacuum pump, 8900 cfm, 350 hp.	49,700
VP-504	1	Vacuum pump, 6700 cfm, 300 hp.	46,700
X-3-500	1	Slurry distributor, 1590 gals.	3,400
X-3-501	1	Wash liquor distributor, 800 gals.	2,600
X-3-502	1	Slurry distributor, 2300 gals.	4,200
X-3-503	1	Wash liquor distributor, 810 gals.	2,600
X-3-504	1	Distributor, 2800 gals.	9,100
X-3-505	1	Slurry distributor, 2900 gals.	9,700
X-3-506	1	Wash liquor distributor, 770 gals.	2,700
X-3-507	1	Slurry distributor, 1530 gals.	6,600
X-3-508	1	Wash Liquor distributor, 1250 gals.	3,100
X-3-509	1	Wash liquor distributor, 1250 gals.	3,100
X-3-511	1	Slurry distributor, 2110 gals.	4,100
X-3-512	1	Wash liquor distributor, 1270 gals.	3,100
X-3-510	1	Wash liquor distributor, 1250 gals.	3,100
X-3-513	1	Wash liquor distributor, 1250 gals.	3,100
X-3-514	1	Wash liquor distributor, 1270 gals.	3,100
X-3-515	1	Liquor distributor, 1250 gals.	3,100
		Pipe, Valves & Fittings	2,623,000
		Hangers,	42,000
		Insulation	14,000
		Lighting - Yard Units	30,000
		Painting	45,000
		Power Centers	96,000
		Instruments and controls	500,000
		SUB TOTAL	$ 13,873,020

b. Structures-- 1 00 Ton Unit

Rotary Drier Bldg., 75' w x 120'lg x 40' high	$ 158,000
Rotary Calciner Bldg., 25'w x 180' lg x 40' high 10' w x 90' lg. x 40' high	95,000
Filter Bldg., 60' w x 120' lg. x 60' high	190,000
Filter Bldg., 90' w x 120' lg. x 60' high 30' w x 90' lg. x 44' high	330,000
SUB TOTAL	$ 773,000

c. Engineering & Construction Costs

Construction Supplies, 4% of Labor	$ 86,902
Insurance & Taxes, 8% of Labor	173,804
Supervision & Field Office, 12% of Labor	260,706
Use of Construction Equipment and Temporary Construction, 5% of Labor	108,629
Engineering & Drafting Process Engineering Engineering Administration	3,125,000
Purchasing, Expediting and Inspection	170,000
Contingency 10%, of Total	1,857,106
Engineering--Contractor Fee 4% of Total	742,833
SUB TOTAL	$ 6,524,980

100 Ton Unit Capital Cost Estimate TOTAL	$ 21,171,000

IV. ECONOMIC EVALUATION

B. OPERATING COST ESTIMATE

Operating cost estimates include ammonia, power, steam, water, fuel oil, direct labor and immediate supervision, maintenance and amortization, taxes, insurance and analytical expenses.

Make-up ammonia and recycled ammonia from the Ammonium Sulfate Decomposition Section are charged to this section. Cost of makeup ammonia is based on production in the New Orleans area, and varies with quantity of ammonia used for makeup in the three plants. Variation of ammonia costs with amount required is shown graphically in RMO 2018. The cost of producing ammonia in the decomposition unit is shown in RMO 2017.

Estimates of the cost of power, steam and water have been made in the Utility Section (RMO 2019). These costs are shown on the operating cost estimates on the following pages. Steam condensate recovered in this section is credited at the same rate as the cost of producing boiler feed water in the Utility Section. A demand factor of 0.8 has been used in determining the electric requirements for equipment.

Power requirements for inside lighting were calculated at 2.5 watts per square foot. Fuel oil has been charged at $0.058 per gallon.

The basis for determining labor costs is as follows:

1. Operators @ $1.77/hr. + $0.04/hr. cost of living increase = $1.81/hr.
2. Helpers @ $1.42/hr. + $0.04/hr. cost of living increase = $1.46/hr.
3. Holiday pay = 1.7%
4. Paid vacations = 3.85%
5. Sick leave = 1.92%

6. Workmen's Compensation & Public Liability Insurance = 1.29%
7. Social Security and Unemployment Benefits = 1.9%
8. Shift differential and overtime = 7.5%
9. Group Insurance and pension = 6.0%
10. Down time = 2.86%
11. Direct supervision @ $450/month

Payroll additions for supervision do not include pay for holidays, vacation, sick leave and down time. Only the lowest level of supervision has been included here. Charges will be added for additional supervision in the Summary Report.

Annual maintenance cost is the sum of 3% of building costs and 8% of equipment costs. Operating supplies are charged at 20% of the maintenance cost.

Annual amortization and depreciation costs are based on a 15 year life for equipment and a 20 year life for buildings. Taxes are charged at 3.8% with 50% evaluation of capital. Insurance is charged at $0.22 per $100 of capital investment.

Estimates of the number and cost of chemical analyses are as follows:

Plant Size, Tons U/Yr.	Number Analyses/Shift			Cost/Analyses
Compound	450	225	100	
Fe_2O_3	9	9	9	$0.92
SiO_2	6	6	6	1.70
P_2O_5	48	30	18	0.93
TiO_2	6	6	6	1.65
Na_2O	6	6	6	1.50
U	3	3	3	1.25
H_2O	57	37	21	0.60
CaO	6	6	6	0.87
Al_2O_3	51	30	15	1.09
SO_4	42	24	12	1.05

These costs were increased 50% to include supervision and labor benefits.

Ammonium sulfate is recovered from the Alumina Section and used as part of the feed to the Ammonium Sulfate Decomposition Section (RMO 2017). The cost of processing ammonium sulfate is credited to the Alumina Section and charged to the Decomposition Section.

Cost of feed solution, overhead, management, general plant facilities, interest and return on investment have not been included, but these items will be included in the Summary Report.

IV. ECONOMIC EVALUATION

B. OPERATING COST ESTIMATE

1. Alumina Recovery Section -- 450 Ton Plant

	$/Hour
Ammonia from Decomposition Section, 41.4 tph. @ $18.09/ton	748.93
Ammonia, makeup, 5.8 tph. @ $45.99/ton	266.74
Power, 25,000 KW @ $0.0075/KWH	187.50
Steam, 100 psig, 1324.8 M lbs/hr. @ $0.435/M. lb.	
15 psig, 753.7 M lbs/hr. @ $0.380/M. lb.	771.97
less condensate, 1209.7 M lbs/hr. @ $0.075/M. lb.	
Process Water, 17,092 M gal./hr. @ $0.0057/M. gal.	97.42
Well Water, 2436 M gal./hr. @ $0.0083/M. gal.	20.22
Fuel Oil, Bunker C, 7022 gal/hr. @ $0.058/gal.	407.28
Labor & Direct Supervision, including 35 operators, 65 helpers, and 6 supervisors/shift.	219.21
Maintenance:	
Buildings = 3% of $3,494,729/8400 hrs.	12.48
Equipment = 8% of $63,083,271/8400 hrs.	600.79
Operating Supplies (20% of maintenance)	122.65
Filter cloth	1.55
Depreciation & Amortization	
Buildings, $3,494,729 @ 20 years	20.80
Equipment, $63,083,271 @ 15 years	500.66
Taxes, 0.038 x 0.5 x $66,578,000/8400 hrs.	150.59
Insurance, 0.22% of $66,578,000/8400 hrs.	17.44
Analytical expenses	42.17
Sub Total	$4,188.40
Credit for processing 52.3 TPH $(NH_4)_2SO_4$	- 162.67
Operating Cost for Alumina Recovery Section	$4,025.73

IV. ECONOMIC EVALUATION

B. OPERATING COST ESTIMATE

2. Alumina Recovery Section -- 225 Ton Plant

	$/Hour
Ammonia from Decomposition Section, 20.7 tph. @ $19.25/ton	398.48
Ammonia, makeup, 2.9 tph. @ $49.84/ton	144.54
Power, 12,400 KW @ $0.0086/KWH	106.64
Steam, 100 psig, 657.8 M. lbs/hr. @ $0.446/M. lbs.	
15 psig, 377.5 M. lbs/hr. @ $0.388/M. lbs.	393.78
less condensate, 598 M. lbs/hr. @ $0.077/M. lbs.	
Process Water, 8,545 M. gal/hr. @ $0.0061/M. gal.	52.12
Well Water, 1218 M. gal/hr. @ $0.0103/M. gal.	12.55
Fuel Oil, Bunker C, 3511 gal/hr. @ $0.058/gal.	203.64
Labor & Direct Supervision, including 30 operators, 58 helpers, and 5 supervisors/shift	191.70
Maintenance:	
Buildings = 3% of $1,706,643/8400 hrs.	6.10
Equipment = 8% of $35,982,357/8400 hrs.	342.70
Operating Supplies (20% of maintenance)	69.76
Filter Cloth	0.81
Depreciation & Amortization:	
Buildings, $1,706,643 @ 20 years	10.16
Equipment, $35,982,357 @ 15 years	285.58
Taxes, 0.038 x 0.5 x $37,689,000/8400 hrs.	85.25
Insurance, 0.22% of $37,689,000/8400 hrs.	9.87
Analytical expenses	28.94
Sub Total	$2,342.62
Credit for processing 26.1 TPH $(NH_4)_2SO_4$	- 81.34
Operating Cost for Alumina Recovery Section	$2,261.28

IV. ECONOMIC EVALUATION

B. OPERATING COST ESTIMATE

3. Alumina Recovery Section -- 100 Ton Plant

	$/Hour
Ammonia from Decomposition Section, 9.2 tph. @ $21.68/ton	199.46
Ammonia, makeup, 1.3 tph. @ $58.34/ton	75.84
Power, 5800 KW @ $0.0099/KWH	57.42
Steam, 100 psig, 294.5 M. lbs/hr. @ $0.470/M. lbs. 15 psig, 166.3 M. lbs/hr. @ $0.411/M. lbs. less condensate, 267.7 M. lbs/hr. @ $0.082/M. lbs.	184.83
Process Water, 3800 M. gal/hr. @ $0.0080/M. gal.	30.40
Well Water, 540 M. gal/hr. @ $0.0131/M. gal.	7.07
Fuel Oil, Bunker C, 1555 gal/hr. @ $0.058/gal.	90.19
Labor & Direct Supervision, including 26 operators, 49 helpers and 4 supervisors/shift	162.79
Maintenance:	
Buildings = 3% of $1,117,380/8400 hrs.	3.99
Equipment = 8% of $20,053,620/8400 hrs.	190.99
Operating Supplies (20% of maintenance)	39.00
Filter Cloth	0.40
Depreciation & Amortization:	
Buildings, $1,117,380 @ 20 years	6.65
Equipment, $20,053,620 @ 15 years	159.16
Taxes, 0.038 x 0.5 x $21,171,000/8400 hrs.	47.89
Insurance, 0.22% of $21,171,000/8400 hrs.	5.54
Analytical expenses	19.62
Sub Total	$1,281.24
Credit for processing 11.6 TPH $(NH_4)_2SO_4$	- 36.15
Operating Cost for Alumina Recovery Section	$1,245.09

V. ALTERNATE PROCESS

Preliminary designs and cost estimates have been made for a process which produces an impure alumina product suitable for feed to the Bayer process.

In this alternate alum is recovered from the leached zone extract in a manner similar to the previous process. Extract from the Filtration Section is evaporated, cooled and reacted with ammonium sulfate to crystallize alum. Alum is filtered from the extract and washed. Instead of crystallizing alum twice to purify it (the procedure followed in the first process), alum is heated after the first crystallization until dissolved and passed through a spray dryer to dehydrate it. The dehydrated alum is calcined to drive off steam, ammonia and sulfur dioxide and to produce an alumina product containing iron and phosphate impurities.

This alternate would bring about changes in the design of the Ammonium Sulfate Decomposition, Sulfuric Acid and Ammonia plants. Ammonium sulfate required to crystallize alum is not recovered in this alternate process, but is decomposed in the calcining step as alum. Ammonium sulfate for alum crystallization is obtained from the Phosphate Recovery Section, (RMO 2016), and by reacting ammonia with sulfuric acid. Excess ammonium sulfate is not available in the process and, therefore, the reactor in the Ammonium Sulfate Decomposition Section is eliminated.

Since makeup ammonium sulfate is required, the size of the sulfuric acid and ammonia plants must be increased. The sulfur dioxide produced in the calcining step is recovered, converted to the trioxide and absorbed in water to form sulfuric acid. The remainder of the acid is produced from elemental sulfur. It is assumed that ammonia produced in the calcining step will not be recovered.

Following are tables showing the capital costs and operating costs of the Alumina, Decomposition, Sulfuric Acid and Ammonia Sections of the 450 tons U/year plants for the two alternates:

	Capital Cost Estimates	
Plant Section	Purified Alumina	Bayer Feed Alumina
Alumina Recovery	$ 66,578,000	$30,619,000
Decomposition & H_2SO_4 Plants	46,894,000	
Sulfuric Acid Plants		25,275,000
Ammonia Plants	14,200,000	19,800,000
Total	$127,672,000	$75,694,000

	Operating Cost Estimates	
Plant Section	Purified Alumina	Bayer Feed Alumina
Alumina Recovery	$ 3,276.80 *	$ 1,862.95
Decomposition & H_2SO_4 Plants	3,489.25	
Sulfuric Acid Plants		3,400.52
Ammonia Plants	413.91 **	1,062.12
Total	$ 7,179.96	$ 6,325.59

* Cost of recycled ammonia included in Decomposition operating cost.

** Cost of makeup ammonia in P_2O_5 Section.

The tables above show that for the alternate process the capital cost is $52,000,000 less and the operating cost is $854/hour less than the first process. However, the alumina product is not as pure as alumina produced in the first process and, therefore, the sales value would be lower. The amount lost by the decrease in sales value would be greater than the amount of money gained by the decrease in operating costs.

This alternate has not been fully evaluated on a pilot plant scale. Better estimates of capital costs and operating costs could be obtained after pilot plant studies are completed