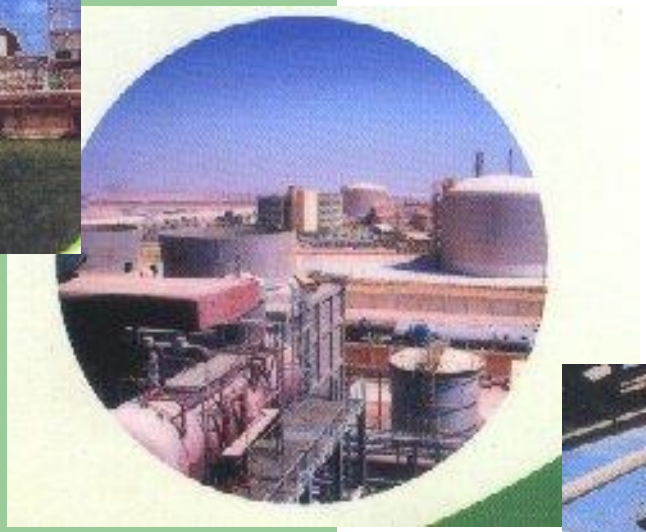
EFIC PRODUCTION PROCESSES



EFIC
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Production Process of Sulphuric Acid

(H_2SO_4)

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Sulphuric Acid (H_2SO_4)

- EFIC and its Subsidiary Company SCFP manufactures Commercial Grade Sulphuric Acid (H_2SO_4 with 98.5 % concentration) through sealed contract process .

- EFIC and its Subsidiary Company SCFP has five production lines :-

  - Two lines in Kafr El Zayat with production capacity up to 540 Ton / day (175,000.0 TPY)
  - Two lines in Assuit with production capacity up to 640 Ton / day (205,000.0 TPY)
  - One line in SCFP with production capacity up to 1200 Ton / day (420,000.0 TPY)

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Sulphuric Acid (H_2SO_4)

- Sulphuric Acid (H_2SO_4) Commercial Grade is :-
  - Colorless
  - Oily Liquid
  - Density 1.847 MTon / m^3

- Raw Sulphur required imported from
  - Saudi Arabia
  - Iran
  - Russia

Raw Sulphur Transported from Ports to the Plant Sites by lorry .

Sulphuric Acid (H_2SO_4)

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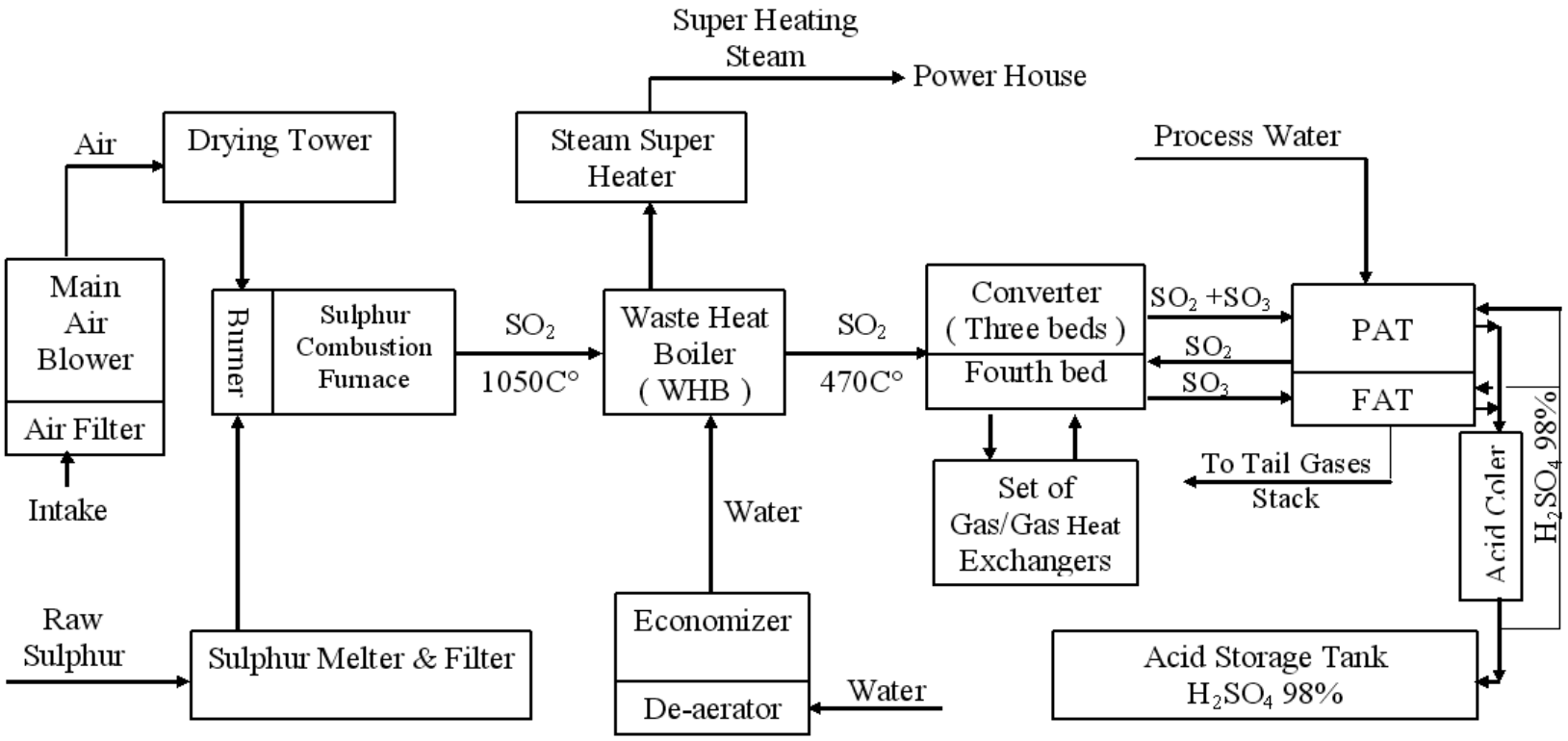
Production Process of Sulphuric Acid can be simplified by the Attached Block flow sheet : -



Sulphuric Acid (H_2SO_4)

- **Raw Sulphur** :-

  Conveyed to the first portion of Sulphuric Acid Plant(Sulphur Melter) .

- **Where** :-

  It is melted using steam coils (with 6.5 barg - 165.0 C°) neutralized by lime , treated by adding pre – coating aid , then filtered using liquid Sulphur Filter equipped with vertical leaf filter able to guarantee an output pure liquid Sulphur with less than 20 ppm ash content to be placed into clean Sulphur Tank with a capacity (200 MTon) 48 hrs operation for the Acid Plant with Full Load.

Sulphuric Acid (H_2SO_4)

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- The Liquid Sulphur pumped through a steam Jacketed Pipe Lines to Sulphur Combustion Furnace. The Sulphur Combustion Furnace is of horizontal design and is directly connected with a horizontal Waste Heat Boiler "WHB" (Fire Tube Construction).

- The liquid Sulphur injected inside the combustion furnace through Sulphur burner which is readily adjustable over a range of 40 – 110 % of design capacity It is designed to ensures rapid and homogenous atomization of liquid Sulphur followed by evaporation . The subsequent total Oxidation / Combustion of the Sulphur with the Inlet Dry Air takes place almost instantaneously producing SO_2 gas, which is exothermic reaction and raise gases temp. up to 1050 C° in the Furnace.

Sulphuric Acid (H_2SO_4)

- SO_2 gas with 1050C^o pass the fire tube Waste Heat Boiler to achieve the following two purposes.
  - Reduce the SO_2 Gas temperature to be 475 C^o as required in the sequence process.
  - Generate a steam used in :
    - Providing the steam required in the Acid Plant
    - Travel to the Power House to drive steam turbine . This generate the majority of EFIC's and SCFP's internal electricity requirements.

Sulphuric Acid (H_2SO_4)

SO_2 gas is sent to the Converter where it passes over Three beds equipped with catalyst Vanadium Penta Oxide (V_2O_5) which converts 92% of the SO_2 gas into SO_3 gas to be sent to the Pre-Absorption Tower (PAT) where SO_3 absorbed and the remaining SO_2 backed to the Fourth Converter Bed to satisfy the 99.7% Conversion efficiency and then the Converted SO_3 sent to the Final Absorption Tower (FAT), which name as Double Absorption System.

Sulphuric Acid (H_2SO_4)

EFIC
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- The Gases has to pass through set of Air Pre-heater , Gas to Gas Heat Exchanges, Economizer , Super Heaters to maximize the benefit of the generated heat in the different beds.

That For Heating :-

* The Inlet Dry Air to the Combustion Furnace
* Super heating the generated steam
* Boiler Feed Water via Economizer
* Returned SO_3 from PAT to the 4^{th} Bed

Sulphuric Acid (H_2SO_4)

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Absorption Towers :

- As Mentioned above The Converted SO_3 after three converter beds absorbed in a Pre – Absorbing Tower (PAT) and the remaining converted SO_3 after leaving the fourth bed absorbed in a final Absorbing Tower (FAT).

- **Where :-**

  SO_3 passed in the towers in counter current to the sprayed cooled concentrated Sulphuric acid 98.5 % where the SO_3 absorbed by the acid, and by adding process water an additional Concentrated Acid produced. Because this process exothermic, the generated heat cause the circulating acid to be heated and accordingly the Acid has to be cooled down in an Anodic Protection Acid Cooler .

Sulphuric Acid (H_2SO_4)

- The Absorption Towers equipped with a ceramic packing to increase the contact surface between the SO_3 gas and sprayed acid. Also equipped with mist eliminator to prevent scabbing of any mist drops from the towers .

- The high conversion efficiency in the converter and the Double Absorption Towers Design together with the heat Balance in the acid plants guarantee a Tail gases emission from the stack is much less than the Environmental requirements

Sulphuric Acid (H_2SO_4)

Ex . The Environmental Requirements for tail gases from the stack

$SO_2 \leq 1500$ mg/Nm^3

$SO_3 \leq 100.0$mg/ Nm^3

EFIC and SCFP plants gas emissions

$SO_2 < 1000$ mg/Nm^3

$SO_3 < 80.0$ mg / Nm^3

- **Note** : for each 1 MTon of Sulphuric acid produced:
  Approx : 1.20 Ton of Superheating Steam produced,(35bar,400C°)
  and hence : 248.0 KW generated.

Sulphuric Acid (H_2SO_4)

- **<u>Acid Storage Tanks</u>** :

  The produced acid (HSO_4 98.5%) stored in acid storage tanks made from carbon steel , EFIC and SCFP has a 14 storage tanks with capacity up to approximately 50000 MTon Conc. Acid

Production Process of Powder Single Super Phosphate

(PSSP)

EFIC
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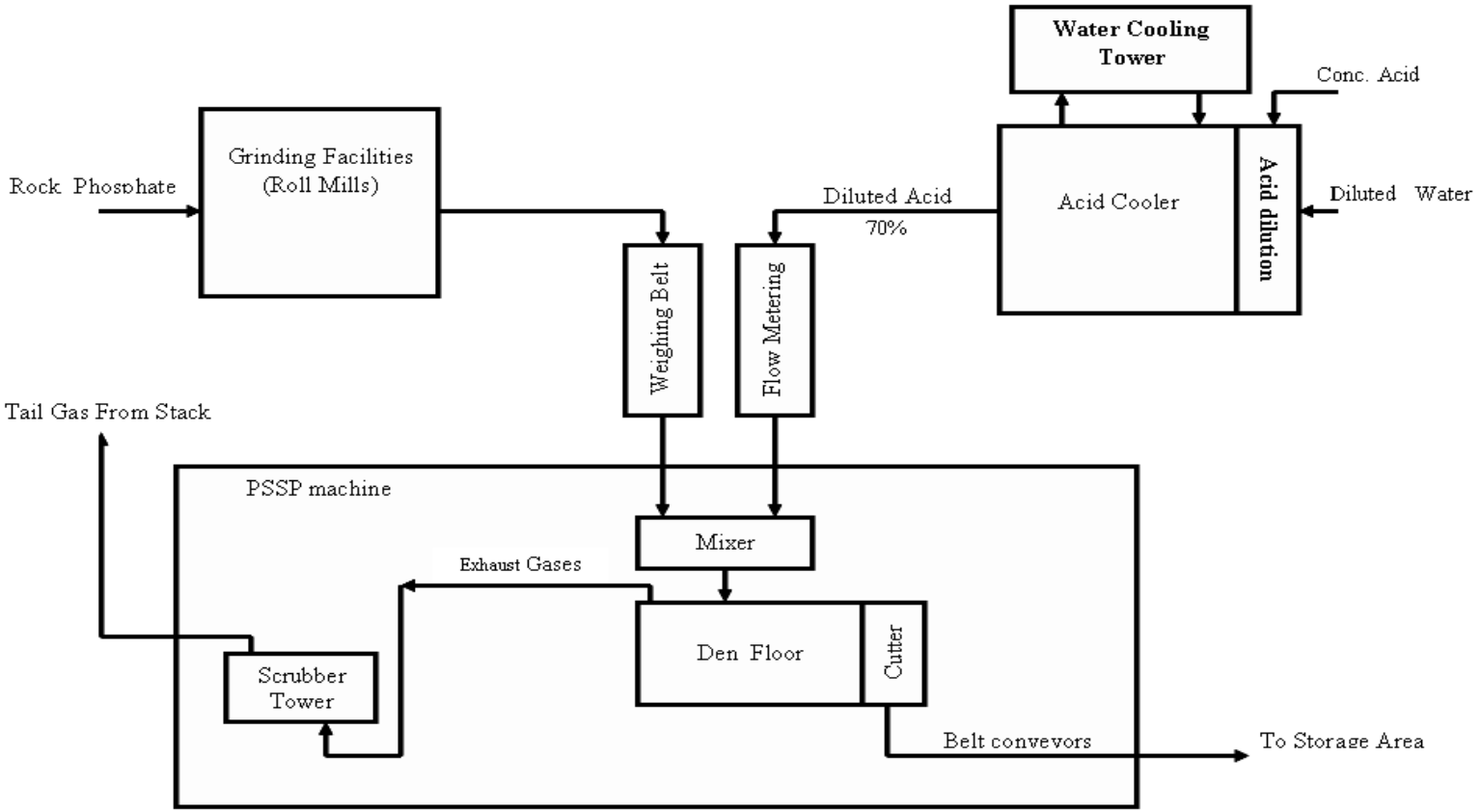
Powder Single Super Phosphate(PSSP)

- The majority(approx. 75%) of the produced Concentrated Sulphuric Acid 98.5% in EFIC and its subsidiary company SCFP mainly used in the production of PSSP .
- Main ingredients are Rock Phosphate and Diluted sulphuric acid with 70% concentration .
- Rock Phosphate mined in the Red Sea area and upper Egypt and transported to plant sites by lorry and trains & barges .

Powder Single Super Phosphate(PSSP)



Powder Single Super Phosphate(PSSP)

- Rock Phosphate conveyed from the storage area to grinding facilities using Roll Mills which grind the rock into powder with finesse 98% at 100mesh.
- EFIC and SCFP has the following Grinding Mills.
  - Kafr El Zayat has two Roll Mills each with outlet capacity 30 M Ton / hr.
  - Assuit has 1 mill with outlet capacity 30 M Ton / hr &
    2 mills each with outlet capacity 20 MTon/ hr
  - SCFP has 1 mill with outlet capacity 25 M Ton/hr

Powder Single Super Phosphate(PSSP)

- Fine Phosphate transported to ground Phosphate Hopper to be used for PSSP production.
- Dilution and Cooling Systems used to Dilute the concentrated Sulphuric Acid 98.5 % to 70 % concentration , and to cool down the produced Diluted Acid(178C°) , because the Dilution Process is exothermic.
- Dilution Process (as a result of mixing water with Conc. Acid) and cooling system is sophisticated systems due to the highly corrosive effect of the Diluted Acid.

Powder Single Super Phosphate(PSSP)

- For that , all parts in contact with Diluted Acid made from especial Graphite can bear the operating conditions . such as :

  Diluted acid inlet Temperature : 178 C°

  Pressure inside the cooler : > 2 bars

- This system fully automated and provide all the safety precautions necessary to guarantee safe operation not only for operators but also for the Graphite Cooler and cable to control the outlet concentration and temperature.
- The Diluted Acid (DSA) stored in Storage Tank lined with Rubber and acid bricks.

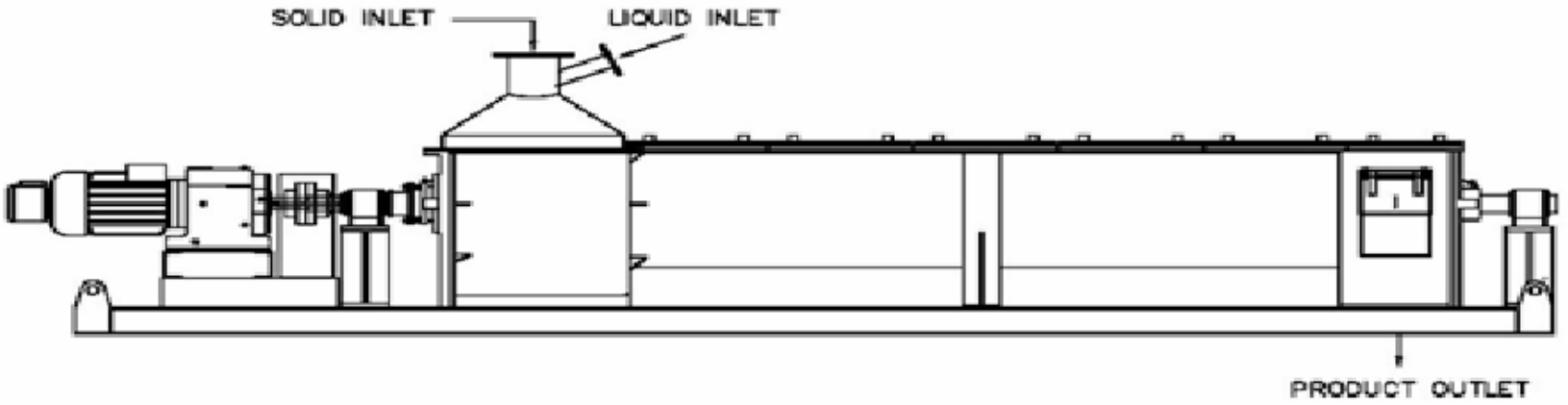
Powder Single Super Phosphate(PSSP)

- The cooling water necessary to cool the DSA re-circulated in water Cooling Tower to minimize the consumed water and in turn the waste water.
- Ground Phosphate sent to the PSSP production plant using suitable material handling equipments such as completely sealed Screw Conveyors , Bucket Elevators… etc.
- Diluted Acid pumped to PSSP production plant using especial chemical pumps.
- PSSP plant designed to use 70 % Sulphuric Acid , recycled scrubber liquor and ground phosphate rock . it is based on the most technically and economically up– to date feasible process and is compatible with Environment Protection Requirements .

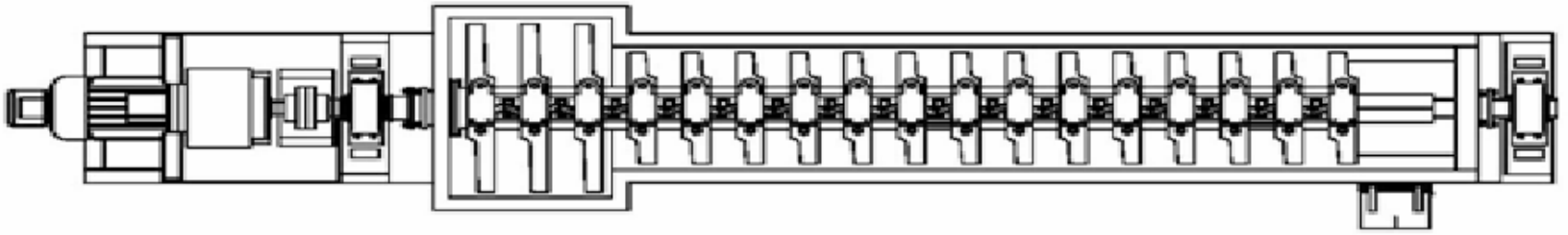
Powder Single Super Phosphate(PSSP)

- Feed Metering is achieved with Automatic Control System
- PSSP reaction is carried out in either Broad Field process as in EFIC plants or as Reaction Belt as in SCFP plant .
- Broad Field Mixer has been developed specially for PSSP manufacture is a large two stage horizontal paddle mixer , the two – stage design ensures complete mixing and good chemical reaction (quality) of SSP powder . Varying speed drive and adjustable paddle configuration allows selection of optimum mixing conditions for all phosphate rocks with Acid.

Powder Single Super Phosphate(PSSP)



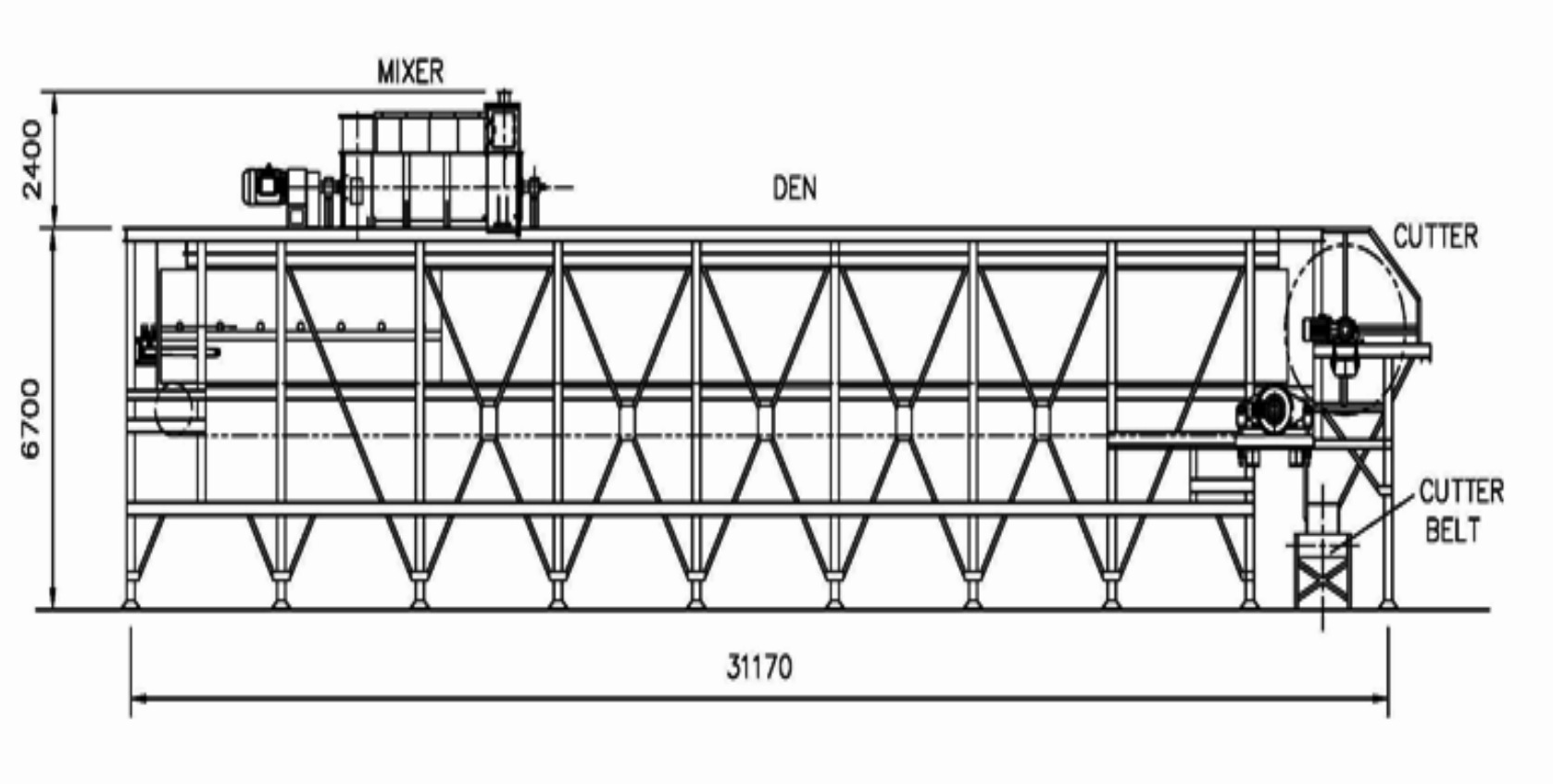
TYPICAL BROADFIELD HORIZONTAL PADDLE MIXER



Powder Single Super Phosphate(PSSP)

- The Broad Field Den Floor is built from steel tee slats , with polypropylene sealing strips , to prevent leakage .
- The reciprocating sides of the Den are lined with cement fondu (special tile) and are driven by two geared motor units through two heavy crank arms . the sides reciprocate slowly to prevent build up of SSP .

Powder Single Super Phosphate(PSSP)



Powder Single Super Phosphate(PSSP)

- A sturdy steel framework carries the den and mixer.
- A rotary cutter excavates the SSP cake from Den stainless steel blades are mounted on a steel frame and shaft carried on externally mounted Plummer block bearings
- The outlet PSSP fertilizer conveyed to storage area to be cured for two weeks before bagging to the market.
- A combined venture and cyclonic scrubber cleans the exhaust gases. This equipment selection is according to the latest proven technology applied in this field, and complies with Egyptian Environmental Law.

Powder Single Super Phosphate(PSSP)

- EFIC has the following PSSP production capacities

Kafr El Zayat plant :

- **One machine with design capacity:70MTon / Hr of Single Supper Phosphate Powder.**
- **Two machines each with design capacity:37M Ton / Hr of Single Supper Phosphate Powder.**

Assuit plant :

- **Same as Kafr el Zayat .**

SCFP plant: has One machine with design capacity :

55MTon/hr of Single Supper Phosphate Powder.

Powder Single Super Phosphate(PSSP)

- **<u>The Stack Emission by the Egyptian Environmental Law</u>**

  Fluorine in exhaust gas : 20 mg F/m^3 of gas

  Dust in exhaust gas : 50 mg / m^3 of gas

- **<u>The Average stack Emission is EFIC and SCFP plants Are :</u>**

  Fluorine in exhaust gas : 6.7 mg F/m^3 of gas.

  Dust in exhaust gas : 7.2 mg Dust/m^3 of gas

Powder Single Super Phosphate (PSSP)

- To produce one ton of PSSP : it requires to mix Ground phosphate with diluted acid with a Ratio as follows:

$$\text{Ratio} = \frac{\text{Diluted Acid (70\%) flow rate (ton/ hr)}}{\text{Ground phosphate (finesse98 \% at 100 mesh flow rate t/hr)}} .$$

=Vary from 0.8 to 1.0 due to phosphate grad .

- The main ingredients consumption for cost evaluation ; its practically to consider for producing one ton of PSSP; The Consumed materials

680 kg of Phosphate &

380 kg of Conc. Sulphuric Acid (CSA)

Granulated Single Super Phosphate Production

(GSSP)

EFIC
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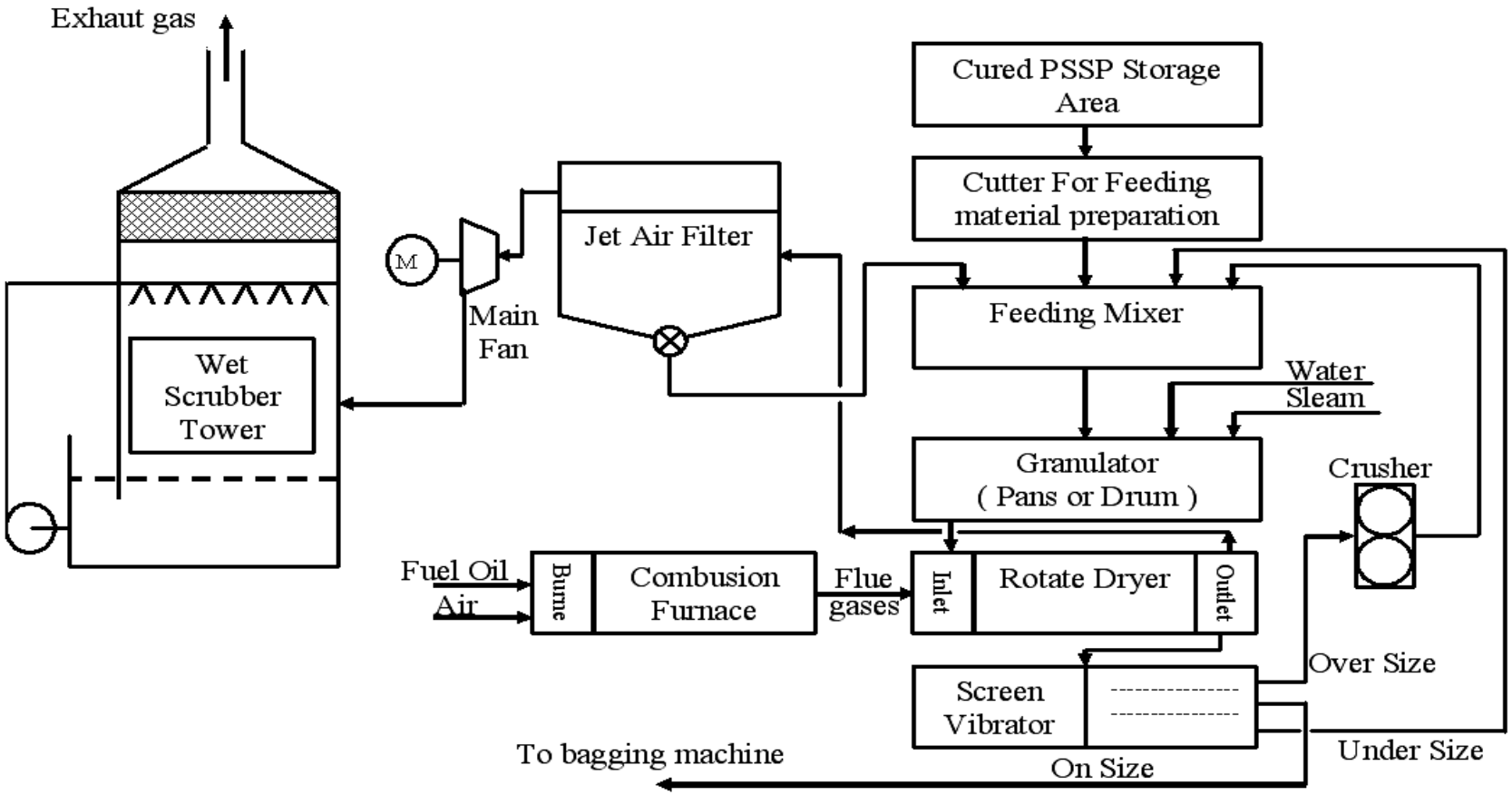
Granulated Single Super Phosphate Production

- Cured Powder Single Super Phosphate Powder , conveyed from the storage area to the Granulation Plant .
- Granulation Process has to follow the following sequence :
  - In order to recondition the feeding cured PSSP, the lump sizes (if exist due to storage) has to be crushed to prepare the powder for the granulation process by using a cutter .

Granulated Single Super Phosphate Production



Granulated Single Super Phosphate Production

- The feeding material (the inlet cured PSSP and the recycled material) must be mixed homogeneously .
- The mixed powder feed to the Granulator (either the Pans or Drum) water and may be steam injected (sprayed) over the PSSP .

- The Granulated SSP at the Granulator outlet has the following specification
  - The SSP humidity is 11 %
  - The granules gradation has to be:

    80 % ≤ 5 mm and ≥ 2 mm

    20 % others

Granulated Single Super Phosphate Production

- GSSP feed to the Dryer in order to dry the granules and to provide an outlet GSSP with max 3 % humidity , that is important to achieve granules hardness ≥ 2.6 kg / granule .
- The flue gases used in the dryer , result of burning Fuel Oil in a combustion furnace.
- The burner with a capacity up to 12 MKCAL suitable for achieving the necessary heat to dry the GSSP .

Granulated Single Super Phosphate Production

- The Outlet GSSP from the dryer sieving out to classify the outlet products to the following :

  - Under size granules , recycled and mixed with the feeding cured PSSP.

  – Over size granules , crushed and recycled to mix with the feeding cured PSSP .

  – On size , with gradation and hardness suitable for selling well locally and Export.

Granulated Single Super Phosphate Production

- The most important consideration in Granulation plant is the de – dusting system , for that the outlet hot gases from the dryer which has a fine dust carried over from the dryer pass through the following de – dusting equipments :
  - Set of high efficiency cyclones .
  - Jet Air Filter can provide an exhaust gas emission with < 20mg dust/m^3 air .
  - Wet Scrubber Tower, to ensure complete comply with the Environmental Requirements .This Tower help to reduce the dust emission by at least l0mg dust / m^3 .

Granulated Single Super Phosphate Production

- EFIC and SCFP has the following Granulation Plants : -
  - EFIC has four lines each with production rate 35 Ton / hr .
  - SCFP has Two lines each with production rate 35 Ton / hr .

Di-Calcium Phosphate Process (DCP) Discription

(DCP)

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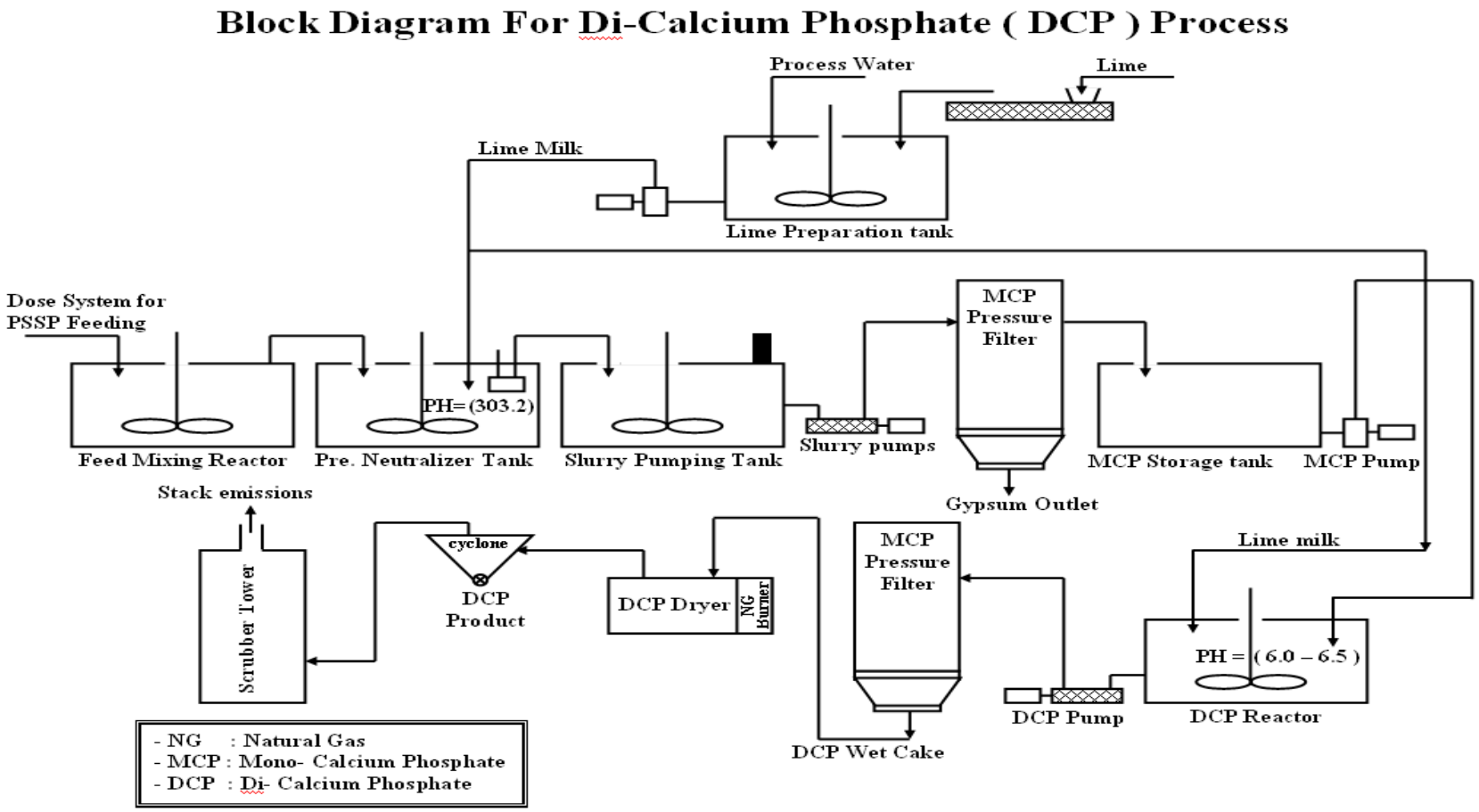
Di-Calcium Phosphate Process

- **SCFP company has a Di–Calcium Phosphate Plant.**
- **The Plant Performance Parameters as follows**
  - **Production Capacity : 62.5 M Ton / day**
    : 20000 M Ton / year
  - **Extraction of water Soluble Phosphate from SSP(if free acid < 4 %) : 93.5 %**
  - **DCP Cake moisture Before the dryer : 26.5 %**
  - **Gypsum Cake : 75 %**
  - **The Consumption of SSP (15% P_2O_5 , 4% free acid as P_2O_5 in SSP) :2.78MTon-SSP/1MTon DCP**
  - **DCP product : Powder , free flow**
    Fluoride (F) content < 0.1 %
    Moisture ≤ 2.5 %.

Di-Calcium Phosphate Process



Di-Calcium Phosphate Process

- The Produced DCP used in Animal Food , Therefore The Fluoride content (< 0.1 %) is the most important figure to be monitored and achieved. It is the bottleneck of this process.

- The knowhow of this process has been registered for the Indian Company AVT , how was the contractor for the DCP plant. This knowhow transferred to SCFP.

- The knowhow of the DCP plant based on extraction of water soluble phosphate from SSP (MCP) and by adding lime milk with very restricted pH control , DCP developed and can be separated.

Di-Calcium Phosphate Process

- **Hereinafter a brief Description for the DCP process according to the attached Block Diagram for DCP process**

1. Fully cured PSSP is fed to mixing reactor through suitable handling arrangement and weighing system to control the feeding dose .
2. Recycled water or filters washing from the plant is continuously fed to the reactor . The Reactor Overflows continuously into neutralizer tanks .
3. The Reactors are equipped with on line pH controllers . The pH correction is made with Diluted Lime Slurry (Lime Milk) from a separate agitated vessel . In this stage the pH controlled to be in the range of 3.0 –3.5

Di-Calcium Phosphate Process

4. Neutralizing reactors are equipped with suitable pumps to convey the slurry to MCP Press filter .
5. Gypsum is filtered of in fully Automatic PLC Controlled press filters
6. Gypsum cake discharged from the Press Filters with approx. 30 –35 % moisture and conveyed to Gypsum yard .
7. MCP solution obtained from the filters led to a storage Tank and then transferred to the DCP neutralizer , where the solution is neutralized with lime slurry to be with pH 6.0 - 6.5 to crystallize out DCP .
8. The Slurry of DCP is filtered through a press filter .

Di-Calcium Phosphate Process

9. Press filters are made of polypropylene plates with recess containing PP cloth as a filter media . Presses are capable of filtering DCP with a product moisture content of not more than 25 % , fully automatic through PLC, together with hydraulic system , washing system ……. etc .
10. A Dryer (Spin Flash Dryer) work with Natural Gas burner to deliver > 3.5 M Ton of dry product per hour containing not more than 2.5 % moisture in final product.

    - The dryer equipped with necessary auxiliaries ;

      forced draft and induced draft (exhaust) fans & bag filter

    - The operation of the dryer is automated by PLC
11. Storage bins have been considered for storing 100MT of finished product.

Di-Calcium Phosphate Process

CONSIDERATIONS IN THE CHOSEN OF DCP PLANT EQUIPMENTS

- Agitators , pumps designed to withstand slurry flows as well as corrosion .
- Wet tanks are protected with pre–vulcanized natural rubber of 4 mm thick .
- DCP plant controlled though smart field instruments , PLCs , PCs DCS and SCADA system .
- MCC panel equipped with motor starters , variable speed drives when ever necessary , motor protections and monitoring for malfunction of the Motors or the Drives.

Ammonium Sulphate Process Description

(AS)

EFIC
EGYPTIAN FINANCIAL & INDUSTRIAL COMPANY

Ammonium Sulphate Process Description

- SCFP company has two Ammonium Sulphate plants with production capacity 900 M Ton / Day .

  300,000.0 MTon/Year

- The produced Ammonium Sulphate:

  with 20.6 % Nitrogen (N_2).

  0.05 % Free Acidity (H_2SO_4)

  0.3 % Water (Moisture)

Ammonium Sulphate Process Description

- The Main Contractor for these two plants is GEA Messo German.
- The Ammonium Sulphate Fertilizer manufactured by the Reaction between the Conc. Sulpheric Acid (H_2SO_4 98.5 %) with Evaporated Ammonia .

Ammonium Sulphate Process Description

- For producing 1 MTon Ammonium Sulphate

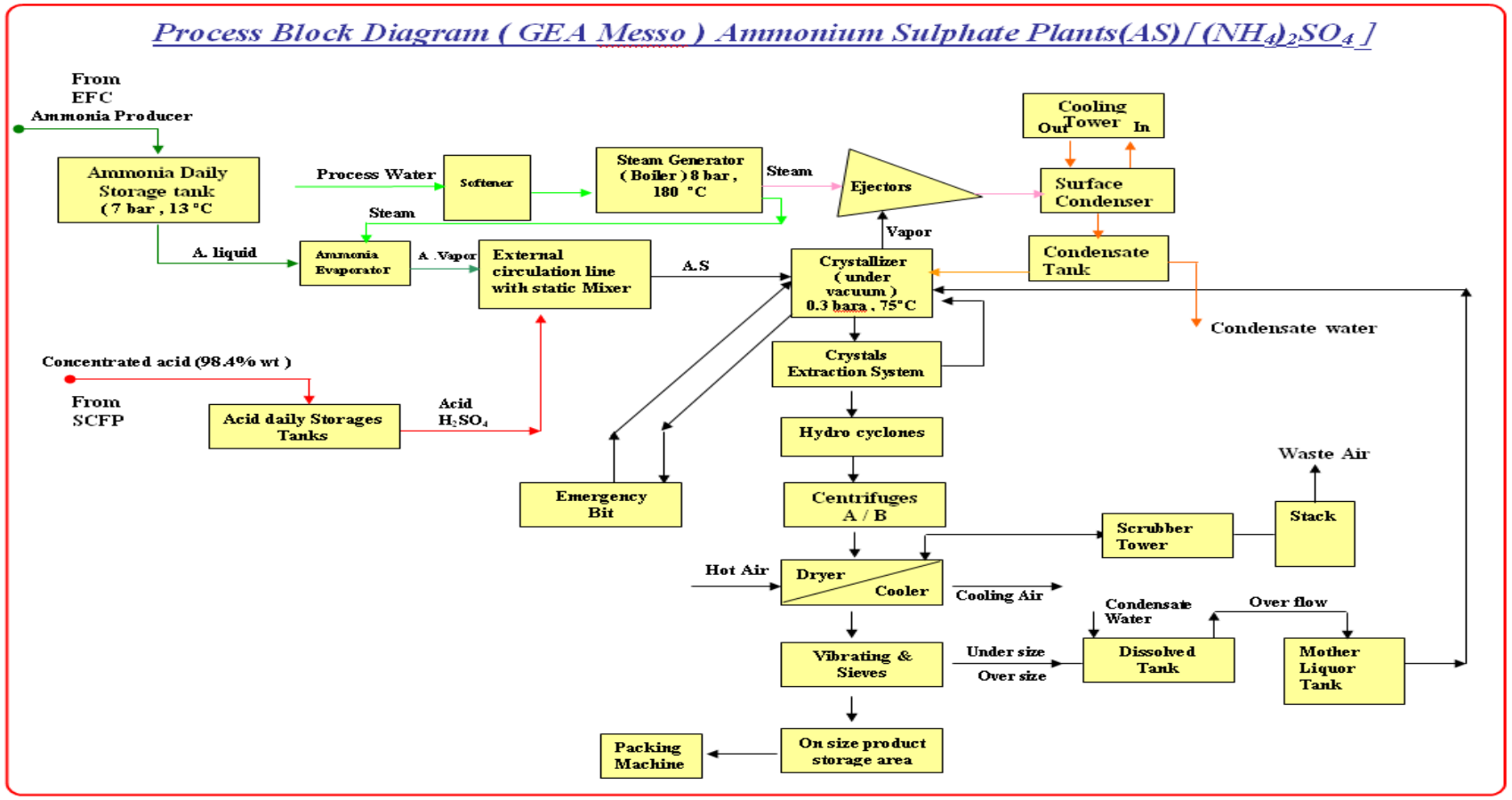
  The Consumed Materials are (approx.) as follows: -

750 kg	H_2SO_4 98.5 %
250 kg	Ammonia NH4

- The produced Ammonium Sulphate is in crystals form with the hereinafter gradations :

90%	$\geq$ 0.5 mm and $\leq$ 4 mm
10%	Others

Ammonium Sulphate Process Description



Ammonium Sulphate Process Description

Ammonium Sulphate Process can be summarized in the following procedures:

1. Concentrated Acid (H_2SO_4 98.5 %) pumped from SCFP Acid Storage Tanks to the Acid Daily Storage Tanks located in Ammonium Sulphate plants .

Ammonium Sulphate Process Description

2. Liquid Ammonia pumped from Egyptian Fertilizer company (EFC neighbor to SCFP) through an Ammonia Pipe Line to the Ammonia Daily Tank with 40 % space with Ammonia Vapor & pressure 7 bar , and accordingly an Ammonium Temperature 13C^o .

3. The Ammonia Vapor Pressure pumping the Ammonia Liquid to the Ammonia Evaporator where the Ammonia Evaporated by inject a steam (7.0 bar , 180 C^o) , and then fed it to the Crystallizer External Tube

Ammonium Sulphate Process Description

4. The Sulphuric Acid (98.4%) react with the Ammonia Vapor producing Ammonium Sulphate circulated by the External Circulation Pump to the Crystallizer .

5. He dosing of Chemicals in the Crystallizer insure the right pH value which lead to the proper Crystal size with minimum residual acid on the crystal. The Ammonia flow rate is measured and controlled . The flow of the Sulpheric acid is a function of the ammonia flow rate with a fine tuning by the pH measurement in the external circulation loop.

Ammonium Sulphate Process Description

6. Due to the Vacuum in the Crystallizer a flashing steam evaporated at liquid temperature 75C^{o} and extracted by Ejectors to the Surface Condenser , where this steam condensate and backed to the Crystallizer .

7. Due to evaporation in the Crystallizer and to the circulation of the A.S Liquid in the External Tube and as a result of the liquid moving due to the Crystallizer Internal Pump , the Crystals generated & the Liquid Density Increased .

Ammonium Sulphate Process Description

8. At recommended Density , the A.S liquid with Crystals extracted by Extraction Pumps (Slurry Pumps) to Hydro – Cyclones , where the Crystals separated and then the remaining Ammonium Sulphate Liquid circulated to the Crystallizer .
9. The crystals out the Hydro–Cyclone (Concentrated Slurry) fed to Centrifuges (A / B) , where the Crystals partially dried and separated from the liquor .Via a vibration chute the Crystallized fed from Centrifuge into the Dryer .

Ammonium Sulphate Process Description

10. The Crystals complete dryness in fluidized Dryer / Cooler unit to provide crystals with :
    - Humidity $\leq 3\%$
    - Temperature $\leq 50C°$.
11. The Crystals then sieves to classify the Crystal sizes and the under or the oversize dissolved and backed to the Crystallizer .

Ammonium Sulphate Process Description

- As indicated in the Process Block Diagram ,The Ammonium Sulphate Plant has the following necessary Auxiliary Items : -

  - Steam Generator : 4 Ton / hr , 7.0 bar 180 C^{o} .
  - Cooling Tower : 1000 m^3 / hr circulated flow rate & 10 C° as Δ T
  - Set of St. St tanks for Dissolved , Mother liquor and Condensate

Ammonium Sulphate Process Description

- Steam Ejectors
- Scrubber Tower
- Stack
- Packing Machine
- Set of Pumps and Agitators
- Automated Smart System .

Ammonium Sulphate Process Description

- The Ammonium Sulphate Plants controlled using PCs, DCS, and SCADA systems .
- The Big Motors Started Softened
- The Control System can be Remoteness Accessible and hence can be maintained by Experts from the Main Office in German.
- The Ammonium Sulphate plants are Environmental Friendly

Emission in Dryer Exhaust:

- Dust 20 mg/ Nm^3 max.
- NH3 12 mg / Nm^3 max.