4. PROCESS IN DETAIL

An end rock kippler and conveyor systems are used to handle incoming gypsum. This is designed to deliver gypsum direct to crushing mills or to stock piles as may be required gypsum stock pile is housed under cover top keep it dry, for wet grinding gives rise to lot of difficulties. The building walls are clothed with steel framed asbestos cement sheet.

Crushing and Grinding Section:

Gypsum lumps are crushed in rotating hammer type crusher, where in size is reduced from 25 cm to 2 cm. This is fed to grinder of capacity 12 tones per hour. The product from the grinder has the size of 90 percent passing through 120 mesh.

Slurry Preparation:

Slurry tank is a ordinary open cylindrical vessel of 1.7 M diameter and height about 2.3 meter. Gypsum and water fed into it in calculated proportion. An agitator (paddle type) is employed which is run at about 50 – 70 r.p.m. After necessary mixing slurry is fed to the Reactors.

Carbonation Section:

In this section carbonation reaction is occurring. Carbonation is done in two welded 99.5% aluminum towers, primary and secondary. All the circulating pumps are made of stainless steel: all piping in this section, of welded aluminum. The reaction taking place is:

$$2NH_4OH + CO_2 \longrightarrow (NH_4)_2CO_3 + 22 \text{ cal/ g mol}$$

almost pure CO_2 enters primary at bottom and passes up counter currently to the carbonate solution trickling down the tower, which is packed with 2-by 2-in stone wire

rings. The un absorbed CO_2 from the top section of which condensate is sprayed. As the amount of liquor is re circulated in each of the towers in order that the packing may be effectively wetted. A part of liquor is bled off into a tank from it is sent to the reaction section.

Reactor section:

Gypsum in slurry form is fed into the first or second vessel of 8 vessel chain, along with the carbonate solution. The normal practice is to use 240 gallons of carbonate solution pr ton of gypsum fed to the reactor vessels, which are cylindrical, provided with stirrer to keep the magma agitated, and arranged for gravity flow. The reaction vessels are made of mild steel, but the gravity lines are of cast iron and the open type impellor pumps and associated piping are stainless steel of type 18/ 8

The reaction in the reactor section is exothermic, hence the reaction vessels are provided with cooling coils. The chemical reaction taking place inside the reactor is as fallows:

$$(NH_4)_2CO_3 + CaSO_4 \longrightarrow (NH_4)_2SO_4 + CaCO_3$$

Filtration; Settling of Calcium Carbonate:

Filtration is done in two stages of rotary drum type stainless steel vacuum filters. In the primary stage the filtrate contains 45 per cent ammonium sulphate. After being washed, the filter cake is scraped and blown from the filter and fed to the secondary filter. The filter cake from the secondary filter, after being washed with hot condensate has the following composition.

$CaCO_3$	-	83%
$(NH_4)_2SO_4$	-	0.865%
$CaSO_4$	-	4.800%
Insoluble	-	5.180%
Water	-	6.155%

The filter cake is pumped to the cement factory as slurry and the filtrate from the secondary filters containing 20 per cent Ammonium sulphate is used for washing

the primary filter cake. The liquor from the first is stored in a liquid tank of diameter 1.75 meter and height 3.86 meter, from which its is fed to Dorr-Oliver type settler.

Filtered liquor from the primary filter contains about 3030 ppm. of suspended calcium carbonate. The settler reduces this to 300ppm. Settler is made up of stainless steel and height of 1.23 meter (conical bottom) and diameter 3.2 meter. The settled liquor contains about 0.386 gm. $(NH_4)_2CO_3$ per 100 cc. Together with some dissolved CO_2 and air.

Ammonium carbonate decomposes to give Ammonia and carbon dioxide when heated over 109^oC

$$(NH_4)_2CO_3 \rightarrow 2NH_3 + CO_2 + H_2O$$

Therefore, the liquor from the settler is sent to a decomposer wherein decomposition of Ammonium carbonate is achieved. Steam coils provide the necessary heat.

Crystallizing Section:

The decomposed liquor flows by gravity from storage tanks continuously into Olso type 'Krystal' evaporator. This is a modern form of evaporation crystallizer. This unit is particularly well adapted to the production of large sized, uniform crystals usually somewhat rounded. It consists essentially of a forced circulation evaporator with an external heater containing a combination salt filter and particle – size classifier on the bottom of the evaporator body. The unique feature of this crystalliser is that a slightly super-saturated solution is passed upward through a bed of crystals, depositing on them the excess solute above saturation and simultaneously classifying them so that only larger ones settle against the stream. Fine crystals and saturated solution leave the top of the bed and are recycled.

Drying; Cooling Section:

Crystals from centrifuge are fed to a counter current rotary dryer wherein hot air at 150°C is used as drying medium.

Internal flights lift the solid and control its cascade through the air stream. The dryer is tilted so that the solids gradually work their way from feed end to the discharge ammonium sulphate crystals which leave at 90°C are cooled in a cooler using fresh air.

Fresh air enters at150°C and leaves at 92. °C. Ammonium sulphate crystals leaving from the cooler will be also at 80°C. These crystals are conveyed to the bagging house.

Storage; Bagging and Dispatch Sections:

Ammonium Sulphate is stored in silos, which are of unique construction. To maintain stocks needed to balance supply and demand under all conditions, storage is provided to three months production at maximum output. The silo is reinforced concrete building. Bagging and dispatch sections deal with the daily production of 250 tones.