CALCIUM AMMONIUM NITRATE

INTRODUCTION

Calcium ammonium nitrate (CAN) is a nitrogenous fertilizer produced by treating ammonium nitrate solution with powdered limestone. It is a white to grey chalky powder, with the colour depending on the limestone used in the manufacturing process. Made with dolomitic limestone, the fertilizer contains 20% nitrogen, 6% calcium and 4% magnesium. If the quantity of limestone is smaller than that of used ammonium nitrate, the nitrogen content can go up to 28%. CAN is preferred to ammonium nitrate in acid soils. The most common grade of CAN contains about 21% nitrogen, corresponding to 60% ammonium nitrate.

Calcium nitrate contains 15.5% nitrogen and its manufacturing process involves reaction of lump limestone with concentrated nitric acid, addition of ammonia to neutralize excess of acid, evaporation of the resulting solution, and prilling or flaking the melt. The resulting product is a double salt, \( \text{Ca(NO}_3\text{)}_2\text{NH}_4\text{NO}_3 \) called calcium ammonium nitrate and is more useful than the single salt calcium nitrate.

Ammonium nitrate is first prepared by the reaction of ammonia and nitric acid. Ammonium nitrate so obtained contains some un-reacted nitric acid which is neutralized by adding calcium carbonate (obtained as a by-product, in the manufacturing of ammonium sulfate) on cooling grains of calcium ammonium nitrate separates out.

The granules of calcium ammonium nitrate are finally coated with thin layer of soap stone powder, which; acts as a protective coating and prevents the absorption of moisture during storage and transportation \( \text{CO}_2 \) is obtained as a byproduct.

MANUFACTURE

Raw materials

<table>
<thead>
<tr>
<th>Basis: 1000kg of CAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia = 70kg</td>
</tr>
<tr>
<td>Nitric acid = 810kg</td>
</tr>
<tr>
<td>Lime stone or dolomite = 425kg</td>
</tr>
</tbody>
</table>
Sources of raw material

Ammonia can be synthesized by Haber – Bosch or Modern process as described in Module: 2, Lecture: 6.

Nitric acid shall be synthesized from Ostwald’s process as described in Module: 4, Lecture: 16.

Lime stone is obtained from mineral calcite or aragonite, which can be used after removal of clay, slit and sand (silica).

Reaction

\[
\begin{align*}
\text{NH}_3 + \text{HNO}_3 & \rightarrow \text{NH}_4\text{NO}_3 \\
\text{CaCO}_3 + 2\text{HNO}_3 & \rightarrow \text{Ca(NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}
\end{align*}
\]

\[
\text{CaCO}_3 + \text{NH}_3+ 3\text{HNO}_3 \rightarrow \text{Ca(NO}_3)_2 + \text{NH}_4\text{NO}_3 + \text{CO}_2+\text{H}_2\text{O}
\]

Manufacture

[Diagram of manufacturing process]

Figure: Manufacturing of Calcium Ammonium Nitrate

Block diagram of manufacturing process
CAN is produced by mixing quickly concentrated ammonium nitrate solution with ground or powdered calcitic or dolomitic limestone. Both prilling and granulation technologies are used to produce CAN.

**Prilling process**

Ammonium nitrate solution is premixed with ground limestone just before prilling. Prill towers of 30 to 50m height are employed. 1 to 3% China clay, kieselghur or calcined fuller's earth is used to condition the prilled CAN. The mean particle size of CAN formed is 2 to 2.5 mm.

**Granulation process**

The various methods used for granulation are

- Pug mill process
- Drum process
- Cold spherodizer process
- Fluid bed process

Calcium ammonium nitrate is produced by granulating concentrated ammonium nitrate solution with pulverized limestone or dolomite in a granulator. Ammonium nitrate solution is prepared by reacting preheated ammonia with nitric acid in a neutralizer. Ammonia is preheated to 85°C by vapours from the neutralizer which also preheats nitric acid to about 65°C. Ammonium nitrate liquor of 82-83% concentration which is produced in the neutralizer is concentrated to 92-94% in a vacuum concentrator heated with steam and stored in a tank.

Concentrated ammonium nitrate is pumped and sprayed into the granulator which is fed with weighed quantity of limestone powder and recycle fines from the screens. The hot granules are dried in a rotary drier by hot air.

Dried hot granules are screened and fines and oversize recycled. Granules of proper size are cooled in a rotary cooler by air and coated with soapstone dust in a coating drum. The final product is sent to storage.

**Comparison of granulation processes**

Pan granulation is difficult to handle as the pan is very sensitive to factors such as heat and material balance. Irregular shape of the product is obtained. The other processes need additives and their melt concentrations are also different. For example, a spherodizer needs ammonium sulfate or magnesium sulfate while a fluid
bed requires magnesium nitrate. In the pug mill process, 0.3 to 0.5 % sulfate as ammonium sulfate is added to improve hardness. The melt concentrations by weight of ammonium nitrate for these processes are as follows: fluid bed 98 to 99%, pug mill 94.5 to 95.5% and drum 93.5 to 94.5%.

Handling and storage

CAN is better to store in air conditioned silos below 30°C. CAN is normally bagged in polyethylene-lined jute or HDPE bags.

PROPERTIES

- Molecular formula: 5Ca(NO$_3$)$_2$.NH$_4$NO$_3$.10H$_2$O
- Molecular weight: 1080.71 gm/mole
- Appearance: White granular
- Odour: Odourless
- Melting point: 169°C (approximately)
- Density: 1.725 gm/ml (20°C)
- Solubility: Solubility in water

CAN is a granulated nitrogenous fertilizer that supplies nitrogen to plants in a balanced and secure manner. The combination of ammonium nitrogen and nitrate nitrogen makes CAN a special product with neutral pH. The excellent granulation and specific surface coating has very good spreading properties.

USES

- CAN is a valuable source of nitrogen. As a fertilizer it can be applied for all types of soil and all plants.
- It is a nitrogen fertilizer supplying nutritive elements (N as NH$_4^+$ and NO$_3^-$, Mg and Ca as carbonates). It is suitable for blending with other granulated fertilizers.
- Commonly used on fruit, process and vegetable crops.