PRESENTED BY

Dr. Piu Dhal

(ASSISTANT PROFESSOR)

DEPARTMENT OF CHEMISTRY

RAMMOHAN COLLEGE,

KOLKATA-700009

DSE-B-1: INORGANIC Materials of INDUSTRIAl IMPORTANCE

FOR SEM 6(H) STUDENTS, PAPER – DSE B1

FERTILISER

What are Fertilizers?

Fertilisers are additional natural or artificial substances supplied to the crops to promote their growth and increase their productivity. These are used by the farmers daily to increase the crop yield. These fertilisers contain essential nutrients required by the plants, including nitrogen, potassium, and phosphorus. They also enhance the water retention capacity of the soil and increase its fertility.

Types Of Fertilizers

A. Fertilisers are mainly classified into two main types, organic and inorganic fertilisers.

Organic Fertilizers

Natural fertilisers derived from plants and animals are known as organic fertilisers. By adding carbonic molecules necessary for plant growth, it enriches the soil. Organic fertilisers boost the amount of organic matter in the soil, encourage microbial reproduction, and alter the physical

and chemical composition of the soil. It is regarded as one of the essential elements for foods that are green.

Organic fertilizers can be obtained from the following products:

Agricultural Waste
Livestock Manure
Industrial Waste
Municipal Sludge

Inorganic Fertilisers

Chemical fertilisers generated by chemical techniques that contain nutrients for crop growth are known as inorganic fertilisers. The inorganic fertilisers are of the following types:

Nitrogen Fertilisers

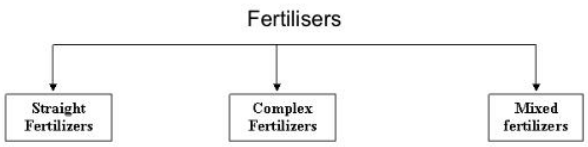
Nitrogen fertilisers contain nitrogen necessary for the development of crops. Nitrogen, a key constituent of chlorophyll, helps main balance in the process of photosynthesis. It is also a part of amino acids in plants and contains protein. Nitrogen fertilisers improve the production and quality of agricultural products.

Phosphorus Fertiliser

In a phosphorus fertiliser, phosphorus is the principal nutrient. The effective phosphorus concentration, fertilisation techniques, soil characteristics, and crop strains all affect how successful a fertiliser is. The protoplasm of the cell contains phosphorus, which is crucial for cell growth and proliferation. The growth of the plants' roots is aided by the phosphorus fertiliser.

CLASSIFICATION OF FERTILISERS

B. Fertilizer is any material of natural or synthetic origin added to the soil to supply one or more plant nutrients.



1. Straight fertilizers: Straight fertilizers are those which supply only one primary plant nutrient, namely nitrogen or phosphorus or potassium.

eg. Urea, ammonium sulphate, potassium chloride and potassium sulphate.

2. Complex fertilizers: Complex fertilizers contain two or three primary plant nutrients of which two primary nutrients are in chemical combination. These fertilisers are usually produced in granular form.
eg. Diammonium phosphate, nitrophosphates and ammonium phosphate, Ammonium Phosphates, Ammonium Phosphate Sulphate, Urea Ammonium Phosphate

3. Mixed fertilizers: are physical mixtures of straight fertilisers. They contain two or three primary plant nutrients. Mixed fertilisers are made by thoroughly mixing the ingredients either mechanically or manually.

Manufacture of Urea

Urea is now prepared commercially in vast amounts from liquid ammonia and liquid carbon dioxide. These two materials are combined under high pressures and elevated temperatures to form ammonium carbamate, which then decomposes at much lower pressures to yield urea and water.

Raw Materials: NH_3 and CO_2

Manufacture: Urea can be manufactured by passing liquid CO_2 and liquid NH_3 in a silver lined special autoclave.CO_2 and NH_3 are compressed and reacted at 100-200 atms and 170^o C - 190^o C in an autoclave to form ammonium carbamate (NH_4COONH_2). Urea is formed by dehydration in a low pressure stripping operation. Process modifications occur in recycling of unreacted NH_3 .

Chemical Reaction:

Urea is synthesized from NH, and CO, in two stage reactions .

1. Formation of ammonium carbamate

$NH_3 + CO_2 \rightarrow NH_4COONH_2$

2. Dehydration of the carbamate to form a melt of urea

$NH_4COONH_2 \rightarrow NH_2CONH_2 + H_2O$

The reaction takes place at 130-135 °C and about 35 atm pressure.

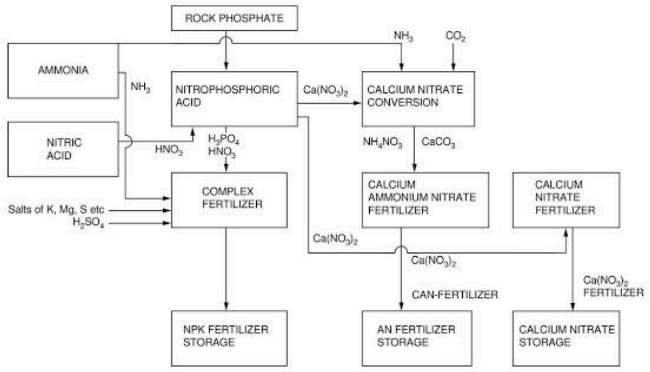
The conversion is about 40%.

Reaction Ratio:

Ratio of NHz and CO, is 2:1

Manufacture of Ammonium Nitrate

Ammonium nitrate is produced by reacting nitric acid with ammonia. The resulting solution is concentrated to 97.5-98% in a final concentrator. The concentrated solution is fed to a prilling tower, and some part of the solution is fed to a slurry tank.



Manufacture of Calcium Ammonium Nitrate

It is manufactured by mixing 75% molten Ammonium Nitrate and 25 % Calcium Carbonate in the mixing tank at 170 Celsius. Around 550 to 700 MT of Ammonium Nitrate is produced per day directly by reacting Ammonia gas and 60% concentration aqueous Nitric acid in the Neutralization Reactor.

Raw material required to produce CAN Ammonia, Nitric Acid, limestone, chalk or Dolomite and soapstone as coating meterial. $NaNO_3$ is explosive so direct application by the formers of india restricled to reduce explosive hazards innert material like, Inne challs, Dalomile: is adied to Miatos so that Fertilizer should be safely handle § ще CAN is produced by granulating cent. salution with pulverized limestone, chalkaY Dalemite in a granulator. Aris salution preparation by reacting first a HNo; in. reacher and cent to ground 90- 32.%. in
ugocum evapt and for keeping mallen

Superphosphate manufacture

The basic ingredients of superphosphate are rock phosphate and sulfuric acid. Sulfuric acid is made by converting elemental sulfur to sulfur trioxide, which, with added water, is dissolved in sulfuric acid to produce more acid. Finely ground rock phosphate and sulfuric acid are mixed in a den to produce superphosphate, which is then granulated and dried. Other nutrients may be added at this stage.

Step 1 - Phosphate rock blending and grinding The phosphate rock is ground until at least 75% is less than 75 m (microns) in diameter, and then analysed for composition. The proportions of various minerals
present are altered to give the desired composition.
Step 2 - Superphosphate manufacture Phosphate rock, sulfuric acid and water are mixed and then allowed to dry and
react to give the superphosphate - a mixture of CaSO4 and Ca(H2PO4): H20.
Step 3 - Granulation The cake of superphosphate is then ground to give particles no more than 6 mm in
diameter.
The basic reaction in the manufacture of superphosphate is the reaction of insoluble phosphate rock with sulfuric acid to form the soluble calcium di-hydrogen phosphate,
$Ca(H_2PO_4)_2$. This is described by the following equation:
$PO_4^{3-} + H_2SO_4 \rightarrow H_2PO_4^- + SO_4^{2-}$
The phosphate rock, imported from Nauru, Jordan, Morocco, Israel and the USA, is
mainly fluorapatite, Cas(PO4) F and is equivalent to 70 - 85% Ca;(PO4)2 by weight. The actual composition of the phosphate rock varies with the source. The sulfuric
acid is produced on the site as described in the previous section.
The reactions occurring during the production of superphosphate are complex and are
usually summarized as follows:

1. $Ca_5(PO_4)_3F + 5\ H_2SO_4 \rightarrow 5\ CaSO_4 + 3H_3PO_4 + HF$
2. $Ca_5(PO_4)_3F\ + 7\ H_3PO_4 + 5\ H_2O \rightarrow 5\ Ca(H_2PO_4)_2H_2O + HF$

These reactions can be combined to give the overall equation:

$2\ Ca_5(PO_4)_3F + 7\ H_2SO_4 + 3H_2O \rightarrow 7\ CaSO_4 + 3\ Ca(H_2PO_4)_2H_2O + 2HF$

There are other reactions occurring at the same time. For example, virtually all the HF reacts with other silica minerals associated with the fluorapatite (silicates, quartz to form silicon tetrafluoride. These gaseous emissions are recovered as hydrofluosilicic acid (H SiF) in the scrubbing system. Carbonates in the rock also react with sulfuric acid.

Used of SSP:

1. Where both POs and sulfur are deficient. SSP may be the most economical way to meet these needs.
2. In Developing countries, where the demand is insufficient production of concentrated Phosphate fertilizer, SSP is the most economical fertilizer can be used in the local areas.
3. SSP is used as a byproduct of sulfuric acid, where sulfuric acid can not be used directly.

Manufacturing of (TSP)

Triple Superphosphate is manufactured in a two stage process.

1. First, sulfuric acid is reacted with phosphate rock, to produce phosphoric acid. Gypsum is a by-product of the stage and is removed.

2. Secondly, the phosphoric acid is reacted with phosphate rock resulting in triple superphosphate.
3. Granulation process is applied.

Chemical Reaction involved in Manufacturing of TSP

$$CaF_2 + 3Ca_3(PO_4)_2 + 14\ H_3PO_4 \rightarrow 10\ Ca(H_2PO_4)_2 + 2HF$$

Triple super phosphate

1. In wet-process phosphoric acid (50 to 55 percent POs) is reacted with ground phosphate rock in a cone mixer.
2. The resultant slurry begins to solidify on a slow moving conveyer on route to the curing area.
3. At the point of discharge from the den, the material passes through a rotary mechanical cutter that breaks up the solid mass.
4. TSP product is sent to a storage pile and cured for 3 to 5 weeks. The product is then mined from the storage pile to be crushed, screened, and shipped in bulk.

Manufacture of Ammonium Phosphate

Ammonium phosphate ($(NH_4)_3PO_4$) also known as ammonium orthophosphate is the salt of ammonia and phosphoric acid. It consists of ammonium cations and phosphate anion. It is water soluble and the aqueous solution on boiling losses ammonia.

There are two major types of ammonium phosphate which are monoammonium phosphate (MAP, $NH_4H_2PO_4$) and diammonium phosphate (DAP, $(NH_4)_2HPO_4$)

1. Monoammonium phosphate (MAP) Anhydrous ammonia added to liquid phosphoric acid gives monoammonium phosphate (MAP). It is a fertilizer or fertilizer intermediate with high P2O; content of about 55% and nitrogen

content 11-12%.

2. Diammonium phosphate (DAP) O With more ammonia, technical grade diammonium phosphate (DAP) containing 16 to 18% nitrogen and 20 to 21 % phosphorus (46% P,0)

is formed.

Raw Materials :

Basis: 1000kg of Diammonium phosphate

Ammonia = 200kg

Phosphoric acid = 465kg

Reactions :

$$NH_3 + H_3PO_4 \rightarrow NH_4H_2PO_4$$

Monoammonium Phosphate

$$NH_3 + NH_4H_2PO_4 \rightarrow (NH_4)_2HPO_4$$

Diammonium Phosphate