

B.Sc Part-III Honours
Subject: CHEMISTRY

Paper-XII
Industrial Chemistry
Topic: FERTILIZER
(Part-I)

What is Fertilizer?

Fertilizers are substances that are added to the soil to increase its fertility or to make it reproductive and also for healthy growths of plants. These substances are added to remove the deficiency of essential elements required for plant. These are naturally occurring inorganic or organic substances. Example of organic fertilizer is urea and inorganic fertilizers are $(\text{NH}_4)_2\text{SO}_4$.

Necessity of Fertilizer: There are mainly 3 fold need of fertilizer:

1. To supplement what has been eaten up by the plant
2. To supply as an additional tonic and good food, so that they may grow more health and produce a better yield
3. To maintain the pH of the soil (7-8) and facilitate optimum growth and health

Manufacture of Urea

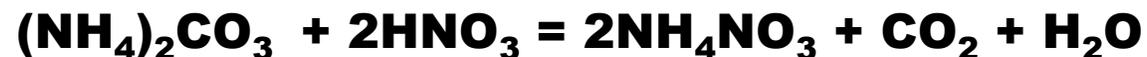
Manufacture of Urea from CO₂ (Sindri method): In India Urea is manufactured by this method by introducing pure liquid ammonia and liquid CO₂ in an autoclave in which the temperature remains at about 182°C and pressure 180 kg/cm². In this manner 37-40% urea is formed.



Unreacted urea and carbon di oxide are converted into ammonium carbamate.



Ammonium carbonate is then allowed to react with dilute HNO₃ to form ammonium nitrate and CO₂.



CO₂ thus formed is then recycled. Urea solution is then concentrated to 78% and then to 97% solution. The concentrated solution is then crystallized into globules.

Manufacture of Superphosphate of lime:

Raw materials: The chief raw materials for the preparation of superphosphate of lime are the following

1. Rock phosphate or phosphorite rock, $\text{Ca}_3(\text{PO}_4)_2$,
2. Chlorapatite, $3\text{Ca}_3(\text{PO}_4)_2, \text{CaCl}_2$,
3. Fluorapatite, $3\text{Ca}_3(\text{PO}_4)_2, \text{CaF}_2$

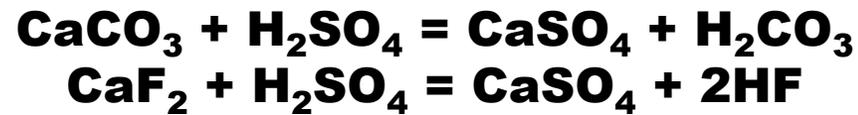
A well powdered phosphate rock or bone ash along with calculated quantity of concentrated chamber H_2SO_4 are introduced in a cast iron chamber fitted with a mechanical stirrer and two vulves at the bottom. Each vulve opens in a big chamber called Den. The mixture is stirred for 2-5 minutes and then dumped mechanically into one of the Dens through the vulve. The mass is kept in the Den for about 24 hours.

Chemical reactions: The following reactions take place in the Den.



The important points to be remembered:

1. The hydrated CaSO_4 produces the setting of the reaction mixture.
2. The temperature of the reaction mass rises upto 100°C due to exothermic nature of the reaction.
3. Since the rock phosphate invariably contains CaCO_3 and CaF_2 as impurities, therefore they react with H_2SO_4 evolving CO_2 and HF



The evolution of CO_2 and HF makes the reaction mixture porous and capable of being easily dried. Because of the above mixtures the mixture gradually stiffens (becomes hard) and finally solidifies to porous dry mass. Then it is allowed to stand for 4-6 weeks. After that the solid mass is crushed into fine powder, while the reactions are going in one Den the second Den can be put to use for next lot.

Manufacture of Triple Super Phosphate (TSP)

Triple Super Phosphate or concentrated super phosphate contains about 44-74% P_2O_5 which is nearly three times as high as in normal super phosphate.

It can be manufactured from the action of 78% H_3PO_4 and finely powdered $Ca_3(PO_4)_2$ or phosphate rock containing about 33% P_2O_5 content. The manufacturing process. The reaction mixture is allowed to stand for about 3 months to make the reaction complete. The grey solid mass thus obtained is crushed to powder.



TSP is essentially an impure mono calcium phosphate made by the following reaction.



The property of TSP depend upon the type of rock and acid used for the production and also on the granular or non granular nature of the product.

Grannuler triple super phosphate is usually prepared by the following three methods:

1. In wet and dry method
2. In slurry granulation method
3. In another granulation process, acidulation and granulation are carried out simultaneously in a rotatory drum.

What are NPK Fertilizers?

Fertilizers containing more than one elements i.e. N, P and K are referred to as **mixed fertilizer or fertilizer mixture or NPK**. Fertilizer mixture are obtained by mixing the N, P and K fertilizer together to give balanced fertilizer. Small amounts of other elements such as B, Mg, Co, Cu and Zn are added as special requirement of the soil. Example of NPK fertilizers are ammonium sulphate, phosphate and potash (KCl) combination. This NPK fertilizer can be prepared by taking anhydrous liquid NH_3 , phosphoric acid (25-30 % P_2O_5), sulphuric acid (93-98%) and potash (KCl) as raw material.

Nomenclature of Fertilizer:

There are various types of fertilizer mixtures indicated by grade. Grade indicates the nutrient content expressed in % age. The grade is expressed as **three digits** even if one or more nutrients are missing. For example urea containing 45% N is indicated according to grade as 45-0-0.

- 1. Grade-1 fertilizer mixture (6-12-0):** It contains 6% nitrogen and 12% phosphoric acid. These are suitable for grain crops.
- 2. Grade-2 fertilizer mixture (10-6-6):** It contains 10% nitrogen, 6% phosphoric acid and 6% potassium. These are suitable for potato, cotton, banana, jute, papaya and vegetable crops.
- 3. Grade-3 fertilizer mixture (6.6-6.5-6):** It contains 6.6% nitrogen, 6.5% phosphoric acid and 6% potassium. These are suitable for grain crops and sugarcane.
- 4. Grade-4 fertilizer mixture (8-8-8):** It contains 8% nitrogen, 8% phosphoric acid and 8% potassium. These are suitable for oilseed crops.