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Paper: DSE3T: Industrial Chemistry

Topic: Fertilizers

PART 1

Comments - Read the lesson in details and practice the flow chart.

Fertilizer - A fertilizer is a plant nutrient added to a soil to increase its yield. Plants need nutrients to grow and produce fruits and vegetables.

Two categories of nutrients have been identified in fertilization.

1. Macronutrients.
2. Micronutrients.

Macronutrients :- There are only six macronutrients and they are required in large amounts : Nitrogen, Phosphorus, Potassium, Sulfur, Magnesium and Calcium.

The most popular fertilizers contain the three major nutrients : Nitrogen, Phosphorus and Potassium. They are therefore referred to as NPK fertilizers

A. Nitrogen fertilizers :- Nitrogen fertilizers are applied in organic or inorganic forms. Nitrogen Organic forms part of proteins, hormones, chlorophyll, vitamins and enzymes and promotes stem and leaf growth. Too much nitrogen can delay fruiting, while a deficiency of it can reduce yields and and induce yellowing of leaves.

Organic Nitrogen fertilizers are farmyard manure, dried blood, horn etc. Organic nitrogen sources must undergo microbial processes that produce nitrate nitrogen.

Inorganic nitrogen sources are directly available to plants and include the following:

(a) Sodium nitrate
(b) Calcium nitrate
(c) Ammonium Sulfate
(d) Urea
(e) Calcium cyanamide and Ammonia.

C. Potassium fertilizer :

Potassium contributes to the formation of sugars, carbohydrates, proteins and to cell division, adjusts water balance, enhances the flavor, colour and oil content of fruits. Potassium deficiency produces a spotted, curled or burned appearance to leaves and lowers crop yields. Potassium fertilizers are applied in the following forms:

(a) Potassium chloride
(b) Potassium Sulfate
(c) Potassium nitrate and
(d) Wood ash.

Other macronutrients are supplied as part of NPK fertilizers.

- Sulfur is available from the sulfate of fertilizers. It contributes to the formation of amino acid, Proteins and enzymes.

In addition, atmospheric nitrogen may be used as a source of plant nitrogen by the process called 'nitrogen fixation'. Few other plants, in association with cyanobacteria (eg.- Anabeana azollae) convert nitrogen to biologically useful ammonia.

B. Phosphorus fertilizer.: Phosphorus plays an important role in seed germination, photosynthesis, protein formation, overall growth and metabolism, and flower and fruit formation. Phosphorus deficiency induces purple stems and leaves, poor flowering and fruiting.

Phosphorus fertilizers come from different sources:

(i) bones (ii) Ammonium phosphate
(iii) polyphosphate (iv) Superphosphate
(v) Nitrophosphate. etc.

- Magnesium deficiency induces yellowing between the veins of older leaves. So magnesium is an important macro nutrients. It is naturally present in the soil. It is a critical part of chlorophyll.
- Finally calcium is also present in the soil. It activates enzymes, influences water movement, cell growth and division.

Manufacturing of urea :→

Urea → NH_2CONH_2.

It is a nitrogen fertilizer. In urea, amount of 'N' is 46.6%. This fertilizer is non toxic. So it is used very often.

Raw Materials :-

(i) Lime stone → $CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$

(ii) NH_3 (gas).

NH_3 is obtained from Haber's process.

$$N_2 + 3H_2 \xrightarrow[450^\circ C,\ 200 atm]{Fe} 2NH_3$$

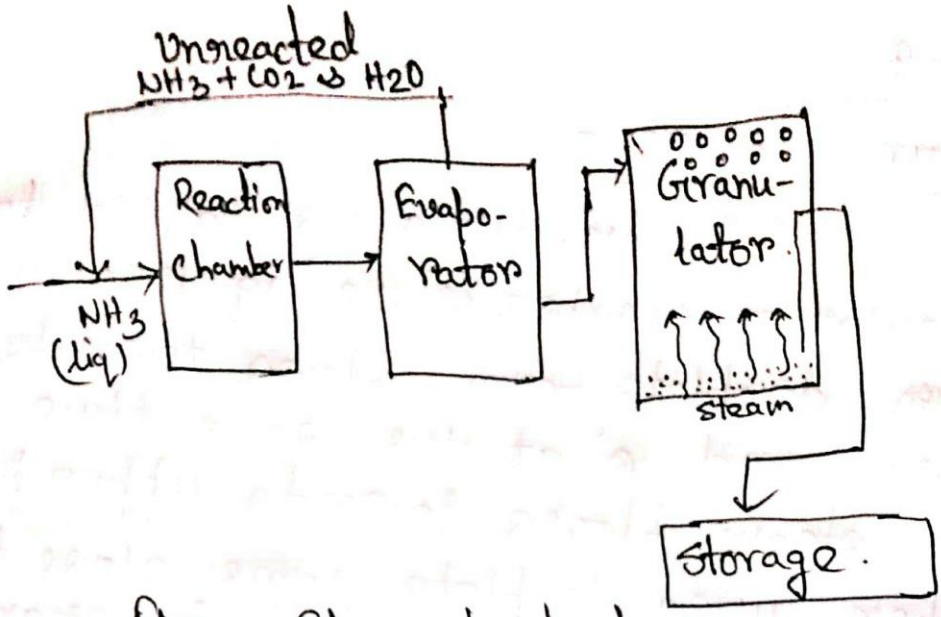


fig → Flow chart of urea processing.

Step : 1

· Formation of ammonium carbamate.

$$\left.\begin{matrix} NH_3 \\ NH_3 \end{matrix}\right\rangle + COO \longrightarrow NH_4COONH_2$$

In this step, ammonia and CO_2 is reacts in reaction chamber to form NH_4COONH_2.

Step : 2

Formation of urea by Evaporation.

$$NH_4COONH_2 \xrightarrow{\Delta} H_2O + \underset{\text{urea}}{NH_2CONH_2}(l)$$

After NH_4COONH_2 formation, it flows to evaporation chamber ~~where~~ at high temp^r. Then water is released and liquid urea is formed.

Step-3

Granulation -

Next liq. urea is passed to granulation chamber where liq urea in ~~form~~ droplets form, flows towards down and at the same time ~~water~~ steam flows towards upper portion, so when urea droplets come close to steam, they are converted to granule forms. After that solid urea is collected in water proof storage. As urea is very hydroscopic in nature.

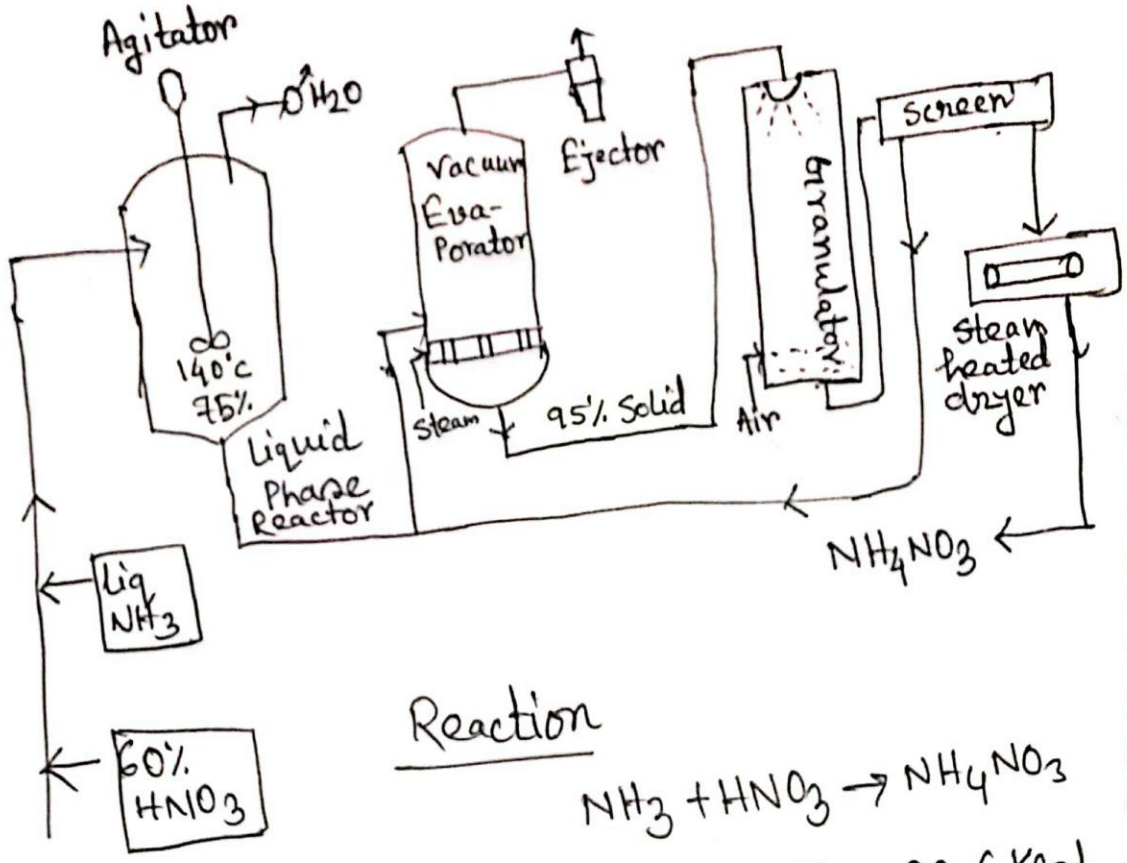
2. Ammonium Nitrate :-

It is manufactured by the neutralizatio reaction between ammonia and nitric acid ~~gas~~ given below.

$$NH_3(g) + HNO_3(g) \rightarrow NH_4NO_3(g)$$

Ammonium nitrate contains 33- 33.5% nitrogen.

Ammonium Nitrate (NH_4NO_3)



Reaction

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

$$\Delta H = -20.6 \text{ Kcal.}$$

Fig:- Flowchart of Ammonium Nitrate (NH_4NO_3) Processing.