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How to Start Manufacturing Industries

Compound Fertilizer NPK Plant – Phosphonitric Process

(Nitrogen, Phosphate and Potash)

Introduction

Main nutrients for crops are Nitrogen, Phosphorous, Potassium and Calcium. These among others must be made available continuously and in correct proportions by the soil.

The individual effect of each of these nutrients is the following:

Nitrogen promotes:
- plant growth-speeds development both above and below ground, influencing the size, weight and colour of the plant yield, e. g. grain, tuber or fruit
- the synthesis of amino acids, protein and lipids, thus contributing in large part to the nutritional value of vegetable foodstuffs
- technical characteristics dependent on the protein content, e. g. the baking properties of wheat

Phosphorus promotes:
- the synthesis of organic phosphorus compounds in the plant organism e. g. phosphoric lipids, nucleic acids, and enzymes necessary for the formation of proteins, carbohydrates and other lipids and enzymes
- the plant's reproductive phase, e. g. the ripeness and quality of seeds and fruit
- the mineral content of plants used in foodstuffs and animal feed

Potassium promotes
- nearly all metabolic processes leading to the synthesis of valuable components such as proteins and carbohydrates
- the vitamin and mineral content (especially of fruit and vegetables)
- technical properties dependent on the carbohydrate content (e. g. the processing properties of potatoes or the malting properties of barley)
- the development of strong plant tissue
- resistance to cold, drought, pests and disease

Calcium promotes:
- the intake of nutrients and transpiration and metabolism in the plant

Soils which are subjected to intensive agricultural usage especially after application of pure nitrogenous fertilizers over long periods such as ammonium nitrate or urea show a deficiency and unbalance in nutrients. This can be leveled by applying compound fertilizers. They offer the following main advantages:
- Compound fertilizers can be produced with different nutrient contents. It is thus possible to provide a fertilizer with optimum nutrient properties taking into account the needs of the crop, the soil conditions and the climate.
- The nutrient components can be dispensed in one operation only.
- Uniform distribution of the nutrients in the soil, since the main nutrient components are present in the desired ratio in every fertilizer granule.
- Separate calcium fertilizing is unnecessary, since many of the available fertilizer types contain calcium.
- Improvement of plant growth by using fertilizer types containing trace nutrients like Mg, Cu, Mn, Fe, Zn, B, Mo, Co as an additional component.

The nutrient content of compound fertilizers is quoted in
% by wt. N
for the nitrogen content
% by wt. P_2O_5
for the phosphate content
% by wt. K_2O
for the potassium content.

Fertilizers with only 2 main nutrients (NP types) – namely nitrogen and phosphate – are monoammonium phosphate, diammonium phosphate. Fertilizer with elevated nitrogen content are urea phosphates and the nitrophosphate fertilizers. NPK fertilizers are produced by adding potassium compounds in the form of potassium chloride (KCl) or potassium sulphate (K_2SO_4).

Several processes are available to produce NP(K) fertilizers. The optimum process can be selected taking into account the availability of raw materials, the prevailing soil and climatic conditions and the type of crop whether the immediate effect or an expanded effect or a combination of both is desired.

Nitrogen in form of nitrate is of immediate effect as well as phosphorus in a water soluble form (mono-or diammonium phosphate and monocalcium phosphate).

Nitrogen in form of ammonium is of expanded effect as well as phosphate in form of dicalcium phosphate, the latter being citrate soluble.

The use of fertilizers with maximum water solubility of the P_2O_5 is recommendable for neutral soils and for plants with a short growth period.

The raw material phosphate rock is available and mined in many places of the world. The rock contains phosphorus in form of tricalcium phosphate which is water insoluble. The phosphorous has therefore to be transformed to a water and/or citrate soluble form, by "attack" with mineral acids such as sulfuric acid and/or nitric acid and/or phosphoric acid.

The Phosphonitric Process

This process is an application of nitric acid and phosporic acid. The fertilizer thus produced always contains a citrate soluble phosphorous portion. Reasonably this process is applied up to a maximum desired water soluble phosphorous portion of 50%.

Capital investment costs are relatively low.

Process Description

"Attack" takes place in an agitator tank. It can be described by the following formula:

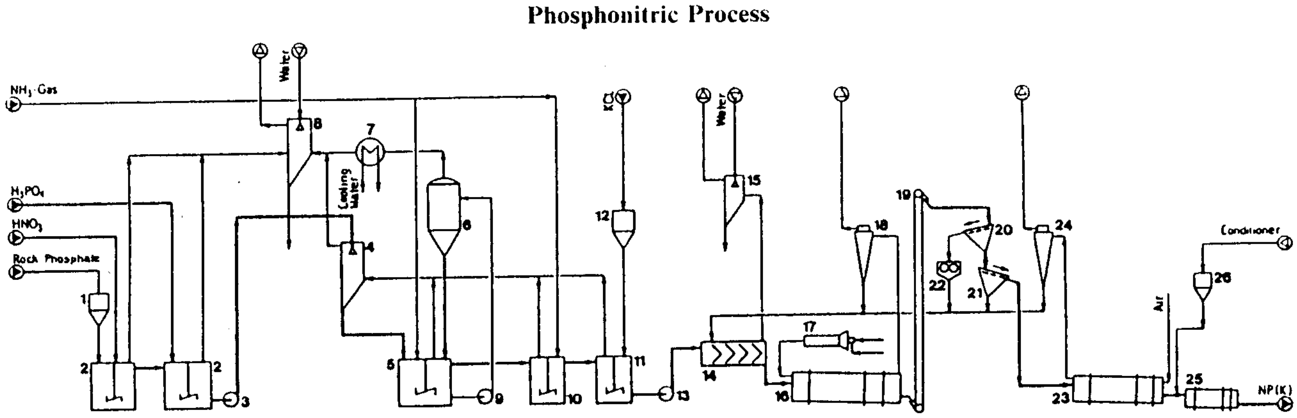
$$Ca_3(PO_4)_2 + 6\ HNO_3 \rightarrow 3\ Ca(NO_3)_2 + 2\ H_3PO_4$$

Phosporic acid is then added to the digestion solution. $Ca_3(PO_4)_2 + 2\ H_3PO_4 \rightarrow 2\ CaHPO_4 + Ca(H_2PO_4)_2$. The quantity depends on the required portion of water-soluble P_2O_5 in the final product. This solution is neutralized with gaseous ammonia in a two-stage neutralization section, thereby producing a mixture of mainly mono- and diammoniumphosphate, dicalciumphosphate and ammoniumnitrate.

The NP solution from the first neutralization stage is recirculated through a vacuum separator, in which the vapours are removed and condensed in a downstream surface condenser. The

Process Flow Diagram

Phosphonitric Process



1. Phosphate rock bin
2. Digester
3. Pump
4. Scrubber
5. Neutralizer
6. Separator
7. Condenser
8. Scrubber
9. NP melt pump
10. Final neutralizer
11. Melt mixing vessel
12. KCl bin
13. Melt pump
14. Granulator
15. Scrubber
16. Drying drum
17. Air heater
18. Dust removal facilities
19. Bucket elevator
20. Coarse screen
21. Fine screen
22. Crusher
23. Cooler
24. Dust removal facilities
25. Coating drum
26. Conditioner bin

ammonia-bearing exhaust gases from the neutralization section are withdrawn and scrubbed with the digestion solution to recover the ammonia. Thereafter, these gases and the exhaust gases from the digester are scrubbed with water.

For the production of fertilizer containing potash, potassium chloride or potassium sulphate is admixed in an agitator tank.

In the granulator, the NPK slurry is granulated.

The granules are dried by means of hot air and then classified. The fines, the crushed oversize and the dust removed from waste air are returned to the granulator. The onsize material is cooled in a fluidized-bed cooler or in a cooling drum, coated with conditioner and conveyed to the product storage.

The exhaust gases from the drying drum, cooling and conditioning equipment are cleaned in the dust removal facilities.

The product can be bagged ex-bulk storage or directly after conditioning. Bags at 50 kg weight are normally used.

Plant Features

(Example of the Plant for 3 Different Capacities)

- Raw materials: Rock phosphate, Jordan 73 BPL; Nitric acid, 60% HNO_3; Phosphoric acid, 53% HNO_3; (Sulfuric acid); Ammonia; Potassium Chloride

- Consumption figures per metric ton of product NPK 15:15:15:

Rock phosphate	197.8 kg
Phosphoric acid (53% P_2O_5)	160.0 kg
Ammonia	67.4 kg (as 100% HNO_3)
Nitric acid (60% HNO_3)	369.5 kg (as 100% HNO_3)
Ammonium nitrate*	
Steam (LP)	0.02 kg
Electr. Energy	50.0 KWh
Cooling Water	–
Oil/Gas	$1.0 \bullet 10^{-5}$ kcal
Process Water	–
Scrubbing water	0.5 m^3

* The addition of ammonium nitrate is only required at a ratio of N:P_2O_5 higher than 0.7.

Plant capacity	300 MTPD	800 MTPD	1,200 MTPD
• Budgetary investment cost under West European conditions in 1986 fob for the process plant: Licence, know-how, engineering and equipment US-$	5.5 Mill.	7.8 Mill.	9.4 Mill.
• Required area for plant size	900 m^2	1,400 m^2	2,000 m^2

- Manpower
  - Operating staff: 1 foreman + 2 skilled workers/shift
  - Other technical staff: Engineers: 1; Chemist: 1; Maintenance: 2

The necessary production machinery and equipment is itemized in the Process Flow Diagram.

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