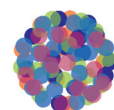


F6 FERTILISERS

PHOSPHATE PRODUCTION



**CHEMICAL
INDUSTRIES**
RESOURCE PACK

Phosphorus

Phosphorus is present in all living cells and is essential to all forms of life. Phosphorus is naturally present in rock, sediment, soil, and organic matter; in fact, it is the eleventh most abundant element in the Earth's crust. Phosphorus is the second most abundant of all the mineral nutrients contained in our bodies. It can be found in every cell, but nearly 80 percent of phosphorus found in people is concentrated in teeth and bones. The source of phosphorus in fertiliser is fossilised remains of ancient marine life found in rock deposits. The countries with the most phosphorus resources are the United States, China, India, Russia and Brazil. In South Africa, phosphate ore is mined at Phalaborwa and at Langebaan.

This material was adapted from an article by the Florida Department of Environmental Protection. Learners - if you use any part of it you need to write it in your own words and include the following in your reference list: WaterandWildlife.org. 1999. Industrial Wastewater Program Phosphate Industry. [Online]. Available: <http://www.tfi.org/factsandstats/fertiliser.cfm> [1 July 2010].

Phosphate production

Phosphate production begins with the mining of calcium phosphate (phosphate rock). Phosphate rock, sand and clay is mined and deposited in a shallow containment area known as a well. While in the well, the matrix is sprayed by high-pressure water guns that liquefy the material into a mixture called a slurry. The material is then transported through pipelines to a beneficiation plant, where the clay and sand are separated from the phosphate rock. Also separated in the process is a mixture of sand and finer particles of phosphate (concentrate) that is then put through a process called flotation. In the flotation process, the mixture is put in a vessel of water where reagents such as fuel oil, soap or fatty acids are mixed in to coat the concentrate and attach air bubbles, allowing it to float, separating it from the sand. Once the phosphate has been separated from

the matrix and dewatered, it is ready to be processed into components used in inorganic fertilisers. In order to make the phosphorus in phosphate rock more readily available to plants, the phosphorus must be in a soluble form. Making fertilisers begins with the phosphate rock being ground into a fine uniform grain size. It is then reacted with sulfuric acid to release the phosphorus from its chemical bond with calcium and other elements. The reaction of the phosphate rock with the sulfuric acid produces phosphoric acid and hydrated calcium sulfate (phosphogypsum), a byproduct. The phosphoric acid is then separated from the phosphogypsum and concentrated. The concentrated phosphoric acid is finally used to manufacture ingredients for inorganic fertiliser.

Examples of ingredients are diammonium phosphate and monoammonium phosphate which are produced when phosphoric acid is reacted with anhydrous ammonia (for its plant-available nitrogen). Another fertiliser ingredient, produced by mixing phosphoric acid with finely ground phosphate rock, is granular triple superphosphate. Meanwhile, water is added to the phosphogypsum byproduct to create a slurry that is hydraulically pumped to a settling dam.

As phosphogypsum dams fill, the solids are scooped out to build up the sides, forming another dam on the resulting phosphogypsum stack that increases in height (up to 70 metres high) as the process continues. The process water that remains after the solids settle out is returned to be reused in processing the phosphoric acid. Without proper treatment aquatic life can be seriously affected when this highly acidic water enters waterbodies from careless spills or failed structures.

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Nitrogen fertiliser



Phosphorus fertiliser

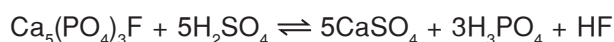


Potassium fertiliser



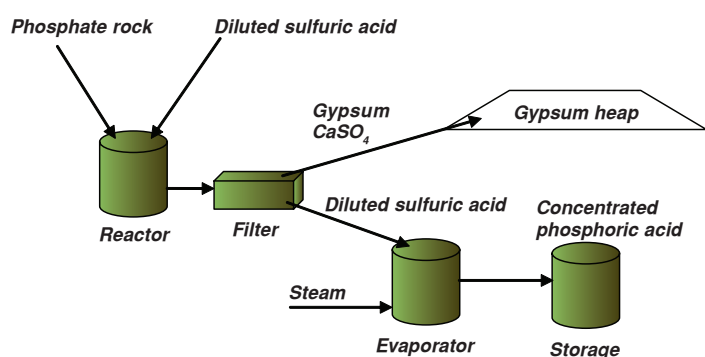
Orthophosphoric acid, H_3PO_4 , and its salts.

The acid is made industrially by treating phosphate rock, usually an apatite like fluorapatite ($\text{Ca}_5(\text{PO}_4)_3\text{F}$) or hydroxyapatite ($\text{Ca}_5(\text{PO}_4)_3\text{OH}$), with dilute sulfuric acid.



The solid calcium sulphate formed is filtered off and the solution of phosphoric acid concentrated up in the evaporator. The main use of phosphoric acid is in the manufacture of phosphates, particularly triple superphosphate and ammonium phosphate, which are used as fertilisers.

Diagram of phosphoric acid production

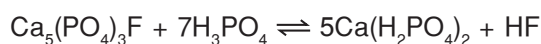


Single superphosphate, SSP fertiliser:



SSP is a mixture of solid $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and solid CaSO_4 and it is about 16% P_2O_5 .

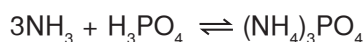
Triple superphosphate, TSP fertiliser:



TSP is about 48% P_2O_5 , and it is called 'triple superphosphate' because its phosphate content is about three times that of SSP.

Ammonium phosphate

Phosphoric acid is also reacted with ammonia to give ammonium phosphate, another good primary fertiliser.



This material was written for this resource pack by Lance Job. Learners - if you use any part of it you need to write it in your own words and include the following in your reference list: Job, L. 2010. Phosphate production. Chemical Industries Resource Pack. University of Cape Town. 2010.

Potassium

Potassium is found in potash, a term that includes various mined and manufactured salts; all containing potassium in a water-soluble form. Potash is produced at underground mines, from solution-mining operations, and through the evaporation of lake and subsurface brines. Minerals mined for potash include potassium chloride (KCl or muriate of potash, MOP), potassium-magnesium sulfate ($\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4$ or sulfate of potash magnesia, SOPM), or mixed sodium-potassium nitrate, ($\text{NaNO}_3 + \text{KNO}_3$ also known as Chilean saltpeter). Manufactured compounds are potassium sulfate (K_2SO_4 or sulfate of potash, SOP) and potassium nitrate (KNO_3 or saltpeter). Deposits of this kind are not accessible in South Africa, and so the potassium required for fertilisers here, is imported as potassium salts.

In 2001, South Africa imported 243 kiloton potassium chloride (KCl) and 26 kiloton potassium sulfate from mainly Belgium, Israel, Russia, Germany and Chile. Potassium is retained by the soil and does not require frequent application, in contrast to the nitrates.



Healthy leaves

DID YOU KNOW?

A slurry is a thick suspension of solids in a liquid.

Potash rock



Source: Potash One Inc.