

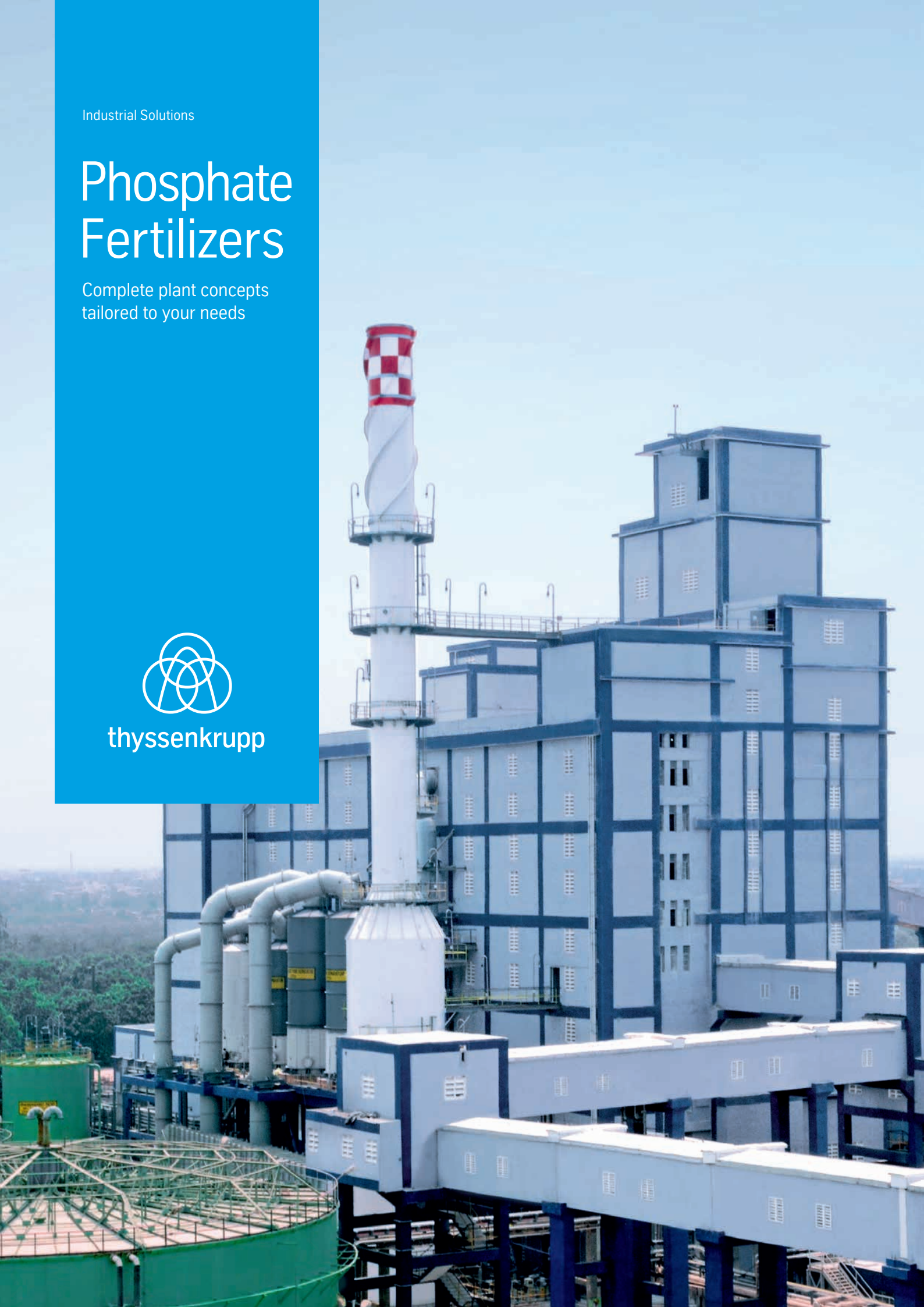
Industrial Solutions

Phosphate Fertilizers

Complete plant concepts
tailored to your needs



thyssenkrupp



The core of a phosphate fertilizer complex is phosphoric acid production. thyssenkrupp designs and builds phosphoric acid plants using technology from Prayon, the global market leader. The phosphoric acid is then processed into fertilizer granules, as shown in the photo. All plant components are specially tailored to customer needs and are designed to meet the specific production requirements, thus providing the basis for a resource-saving and cost-efficient use of feedstocks.



From rock to phosphate fertilizers

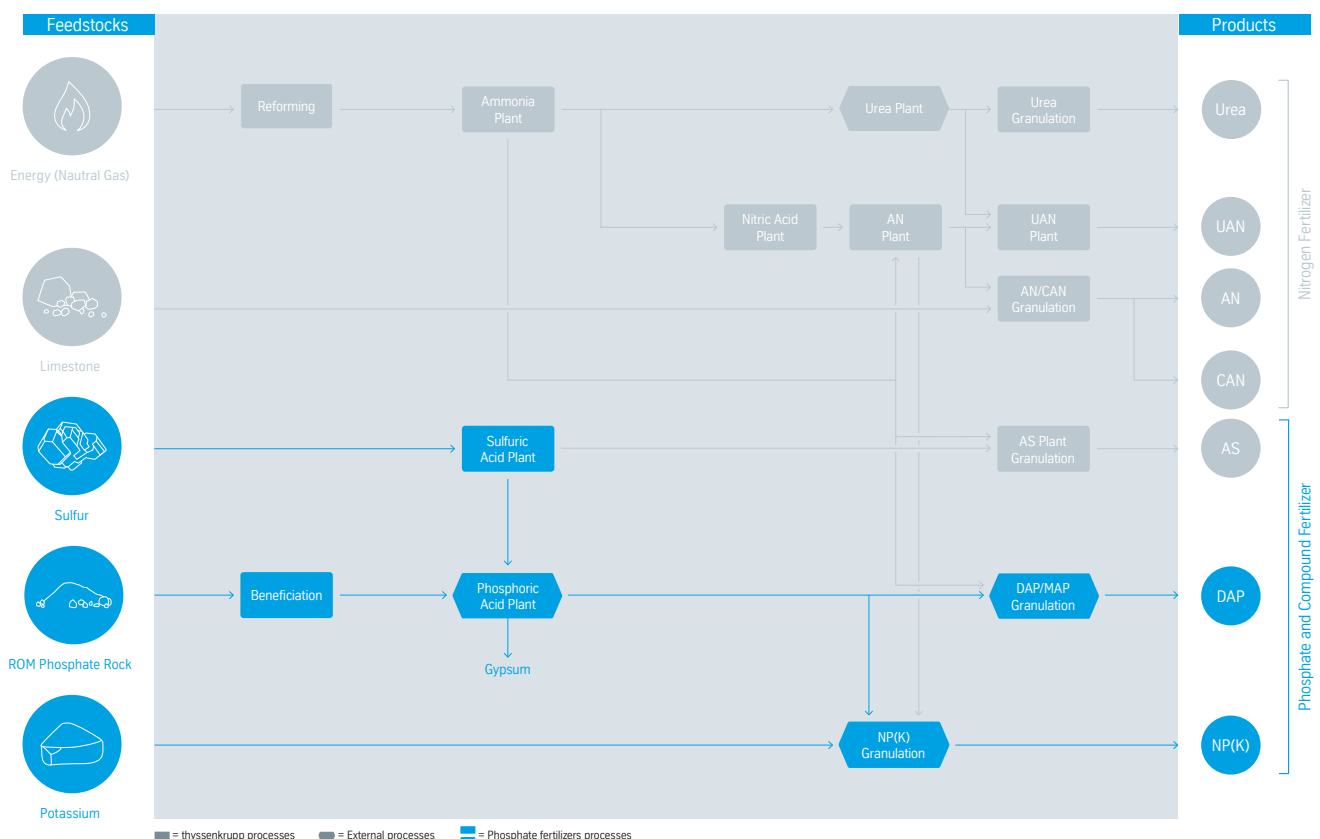
thyssenkrupp Industrial Solutions has decades of experience in supplying single-source turnkey solutions to the fertilizer industry.

Many requirements have to be met by the fertilizer producers: stringent environmental regulations are as much in focus as the demand for increasing capacity. Old plants have to be modernized or replaced. A number of companies also decide to implement new multi-product fully integrated fertilizer plants, to produce various fertilizers.

thyssenkrupp is a competent partner in accomplishing all these tasks, supporting customers throughout the world with complete concepts, first-class engineering and reliable services: We assist you with all processes, from the initial rock mining to shipment of the product. Moreover, we implement solutions in cooperation with equally experienced and competent partners. This means that our customers benefit from tailored project management with a single point of contact.

We offer extensive services to cover the entire life cycle of the plant. Therefore, plants are always optimally serviced and maintained to ensure optimum productivity at all times.

The complete process chain for the production of various fertilizers:



Mining and processing

From the mine to the plant



- Bucket-wheel excavator systems
- Systems for
 - crushing
 - screening
 - washing
 - grinding
 - classifying
 - beneficiation
- Conveyor systems and stockyard equipment

Process plants

Via sulfuric acid and phosphoric acid to fertilizer



Life-cycle solutions for your plant

- Complete new plants on an EPC basis, for the production of
 - ammonia
 - sulfuric acid
 - phosphoric acid
 - DAP, MAP, TSP, SSP, NPK and other special fertilizers
 - crystalline fertilizer
- Studies and modifications of existing plants
- Asset management, operating and maintenance services
- Feasibility studies for new plants, capacity increase, optimization of environmental regulation

360° services for your investment

➞ New plants ➞ Performance improvement ➞ Revamps ➞ Modernization ➞ Spare parts and spare part management

As a leading partner for complete technical concepts and solutions for the fertilizer sector, thyssenkrupp Industrial Solutions offers the full range of processes, products and services for phosphate production in the mineral fertilizer industry. We cover the whole process chain, from project development to commissioning, and supply after-sales services.

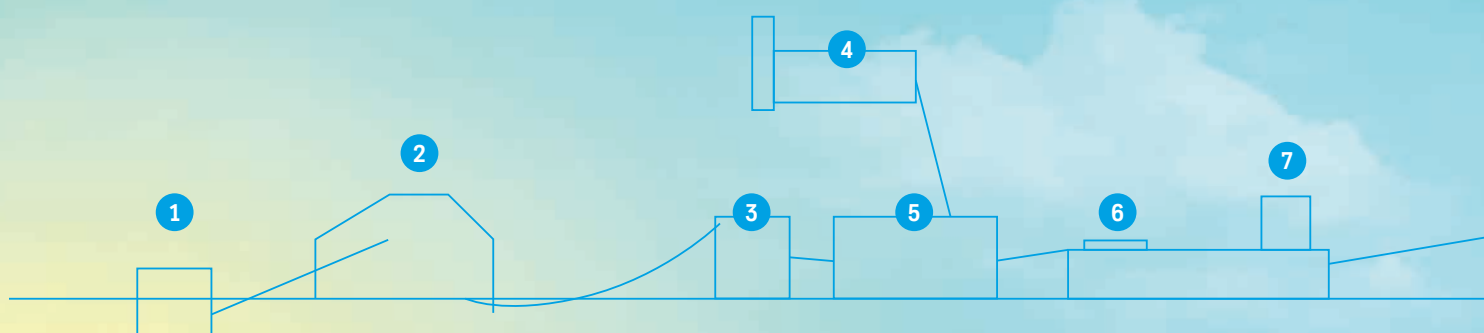
We supply everything you need for your project throughout the entire process chain, from project development to EPC delivery, including the licenses.

Storage area and port-handling equipment

From the plant to the ship, via the storage area



- Reclaimers
- Stackers
- Conveyor systems
- Storage
- Ship loaders
- Bagging lines



Preparation of raw material

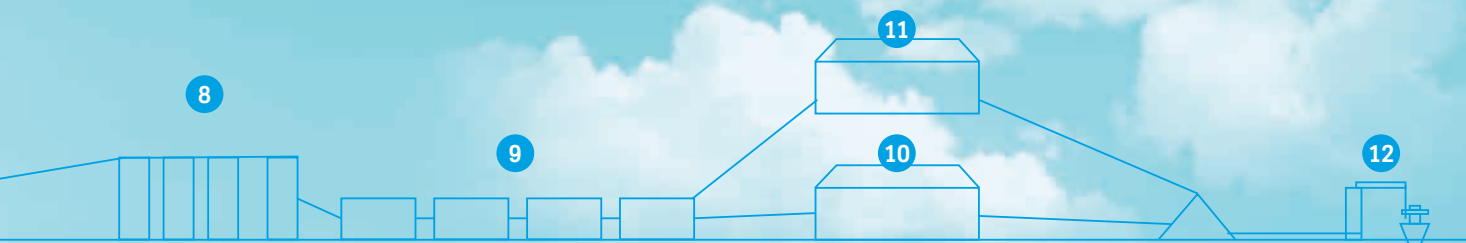
1. **Crushing:** The raw material is crushed to the size of coarse gravel.
2. **Beneficiation:** The phosphate ore is optimized for the production of phosphoric acid (e.g. reduction of calcium, silicon, manganese oxide, organics and carbon dioxide).
3. **Grinding:** The raw material is ground to the required fineness in a mill and simultaneously dried if required.

Phosphoric acid production

4. **Sulfuric acid:** Elemental sulfur is molten and burned. The sulfur dioxide produced is catalytically converted to sulfur trioxide and absorbed in water, forming sulfuric acid.
5. **Phosphoric acid:** Phosphate rock is fed into the reactor at a controlled rate and digested by sulfuric acid, forming phosphoric acid and gypsum (calcium sulfate dihydrate or calcium sulfate hemihydrate).
6. **Filtration:** The phosphoric acid is separated from the gypsum in a tilting-pan filter or a belt filter and is pumped to the weak-acid intermediate storage and settling unit.

The production of phosphate fertilizers – processes and plants

Producing phosphate fertilizers requires much more than a stringing-together of equipment and individual processes. With our outstanding expertise in both the processes and plants involved, thyssenkrupp Industrial Solutions develops complete overall concepts.



Phosphoric acid qualities

7. **Concentration:** The filtered acid is concentrated to merchant grade (48–54%) by evaporation.
8. **Storage of phosphoric acid:** The phosphoric acid is stored in tanks.
9. **Phosphoric acid of technical or food-grade:** The phosphoric acid is further concentrated and purified in line with the required purpose of the product.

Phosphate fertilizer production

10. **Granulated fertilizer:** Phosphoric acid is used to produce granular fertilizers, for example by neutralization with ammonia to form monoammonium phosphate (MAP) or diammonium phosphate (DAP), or by granulation of various NPK formulations.
11. **Crystalline fertilizer:** Phosphoric acid is also used to produce water-soluble crystalline fertilizer.
12. **Storage, bagging and loading:** The finished fertilizer is transferred to the storage area. Then, it is loaded into bulk transporters or bagged.



Production of phosphoric acid

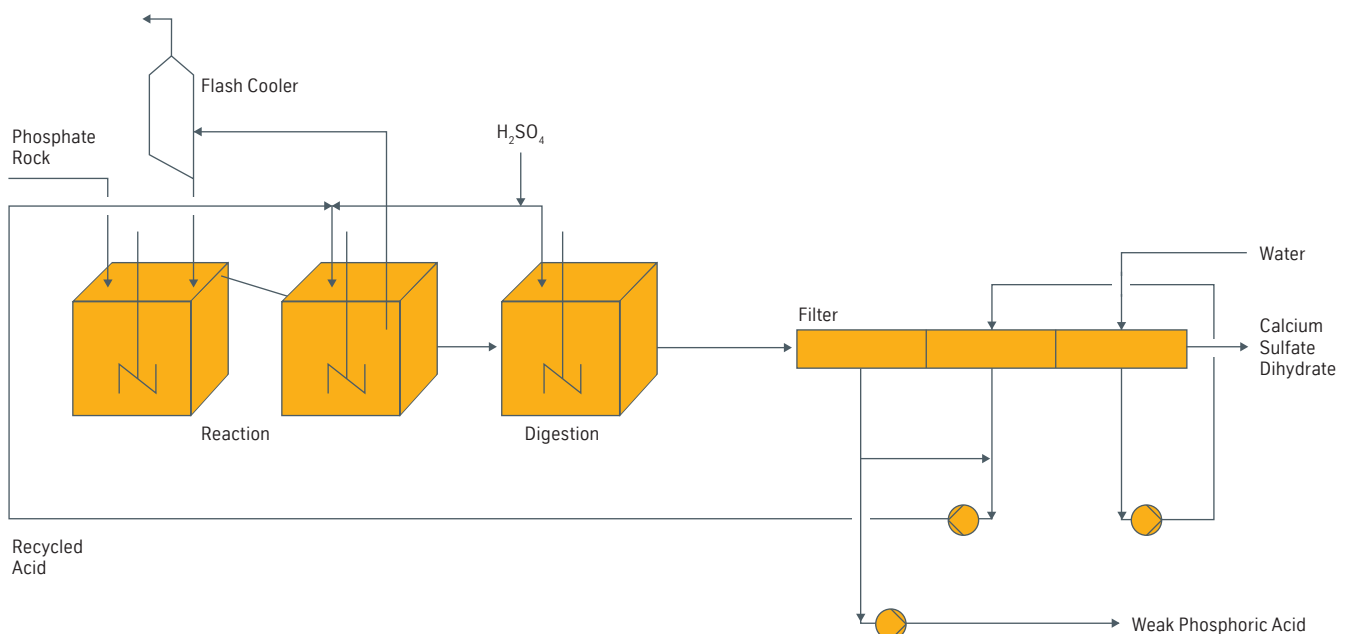
The core of a phosphate fertilizer plant

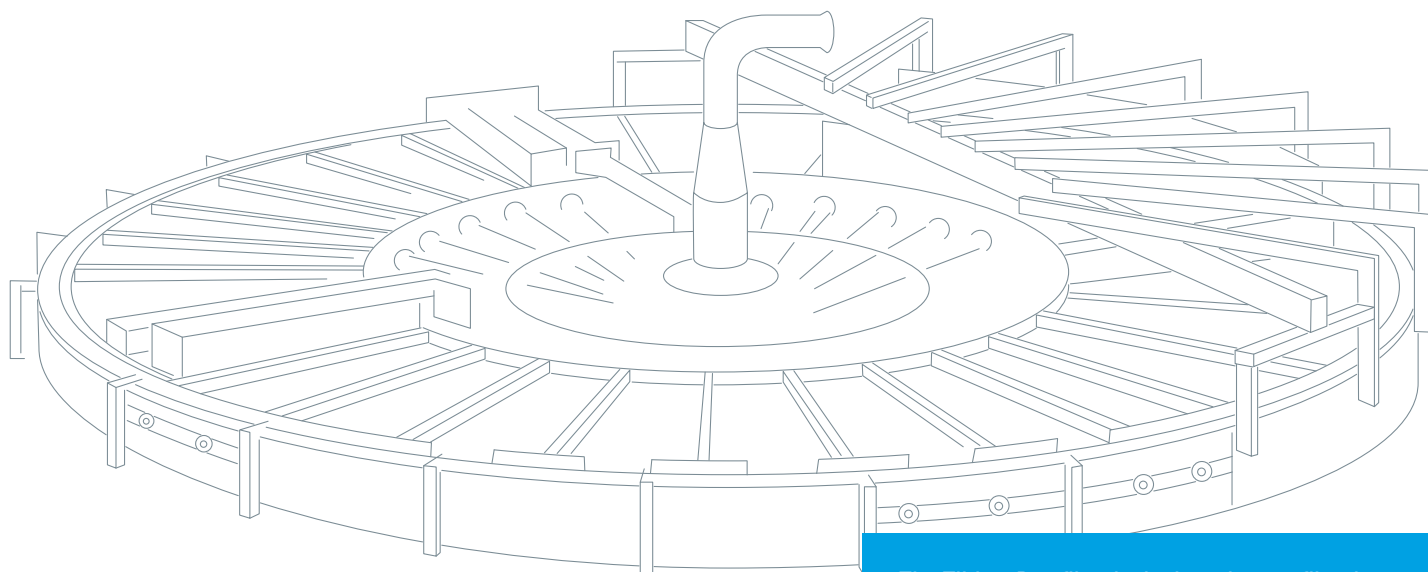
The most common process for the production of phosphoric acid is the dihydrate process, which has been optimized over the years. We offer several alternatives for the production of phosphoric acid. These differ in the formal P_2O_5 yield from the phosphate rock and in the concentration of the phosphoric acid produced. Table 1 shows the different processes. All processes are available with either the tilting-pan filter or the belt filter. Depending on the phosphate rock quality and requested/desired production capacity, thyssenkrupp Industrial Solutions offers the most advanced feasible process plant design.



Phosphoric acid tank, Coromandel, India

Dihydrate process (DPP)





Prayon Tilting-Pan Filter



The Tilting-Pan filter is the best-known filter in the dihydrate phosphoric acid industry. The filter has been refined and optimized over the years, and now has the best washing efficiency of all filters available on the market.

In the phosphoric acid process, the sulfuric acid reacts with the phosphate rock, forming phosphoric acid and calcium sulfate (gypsum). The mixture of these two is sent to a filter to be separated in several washing steps. In subsequent steps, the filtered acid is then concentrated via evaporation systems in order to achieve merchant-grade phosphoric acid.

Table 1: Process alternatives for the production of phosphoric acid

Process Name	DPP	CPP	PH3	PH2	PH1
First Reaction Type	Dihydrate		Hemihydrate		
Solid Product Type	Dihydrate	Hemihydrate	Hemihydrate	Dihydrate	Hemihydrate
Produced Acid: %P ₂ O ₅	28.5	34 to 36	43 to 46	43 to 46	39 to 45
P ₂ O ₅ Yield: %	95 to 96	> 98.5	> 98.5	> 98.5	92 to 95
Gypsum Quality	Low	Very High	Very High	High	Low
Energy Consumption	High (steam)	Low (steam)	Low	Low	Low

A reliable partner from mine pit to port

thyssenkrupp Industrial Solutions offers the full range of know-how in the phosphate industry: From mining companies who extract the phosphate rock, up to fertilizer producers and port operators who require material-handling facilities.

Our portfolio includes a wide range of mining equipment for extracting phosphate rock and for its subsequent beneficiation. More than 15,000 projects for obtaining the best rock quality for processing purposes have already been successfully completed.

thyssenkrupp has a proprietary sulfuric acid technology with a patented process for highly efficient energy recovery. For phosphoric acid technology, we suggest making use of the global market leader, Prayon. For granulation to finished fertilizer, we co-operate, for example, with Incro.

Therefore, our customers can be sure that they get the best technology tailored to operational optimum and local requirements. Industrial Solutions offers this expertise from a single source, from mine pit to port, for new plants or existing ones.

For the fertilizer logistics from the plant to the port, we offer our customers the full range of options for tailored, innovative solutions.



GSFC granulation plant in India

Strong technologies from a single source

thyssenkrupp offers the most advanced solution
for your plant and raw materials.

Treatment of Phosphate Ore,
Beneficiation

thyssenkrupp Process



Sulfuric Acid

thyssenkrupp Process



Phosphoric Acid

Prayon Process



Ammonium Phosphate Neutralization

Incro Pipe Reactor Process



Phosphate Fertilizer Granulation
(DAP/MAP/TSP)

Incro Drum Granulation Process



In response to the desired fertilizer product, the most advanced technology will be selected.

Industrial Solutions
Fertilizer & Syngas Technologies

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