

Industrial Solutions

Nitric acid plants

Efficient, economic and environmentally friendly



thyssenkrupp





The absorption tower is one of the key elements of the nitric acid plant and, with its many cooling coils connections, one of the most unmistakable.

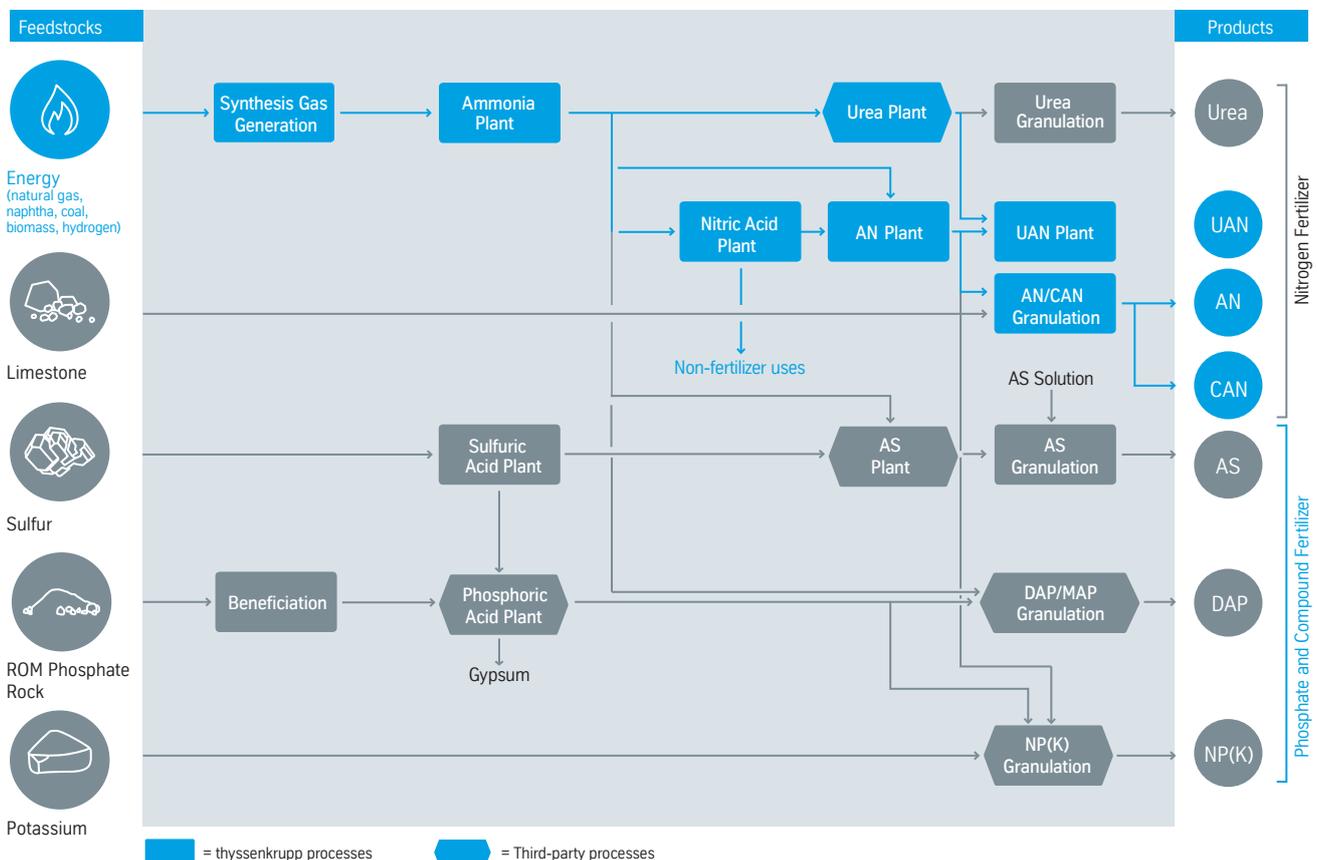
Know-how that breeds success

With over a century of involvement in nitric acid plant design and construction, more than 80 years of experience in the fertilizer sector and more than 360 plants engineered and delivered, thyssenkrupp Industrial Solutions is best placed to serve the industry with proven, economic and environmentally friendly processes.

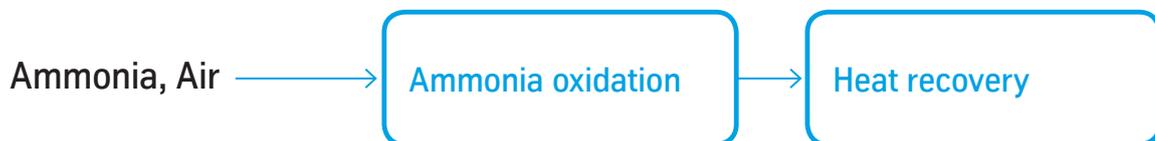
We can deliver the full range of plants for the production of single-component and mixed nitrogenous fertilizers, based on both our own proprietary and renowned licensed technologies. For the non-fertilizer industry we can supply plants for azeotropic nitric acid. Our EnviNOx® tail gas treatment technology, the gold standard of performance for N₂O and NOx emission reduction,

makes our nitric acid plants environmentally friendly. The diagram below provides an overview of the principal fertilizer routes as well as the available processes and main licensors. This brochure describes the processes we offer for nitric acid manufacture. Our nitrates, urea, ammonia and EnviNOx® tail gas treatment processes are covered in separate publications.

The complete process chain for the production of different fertilizers:

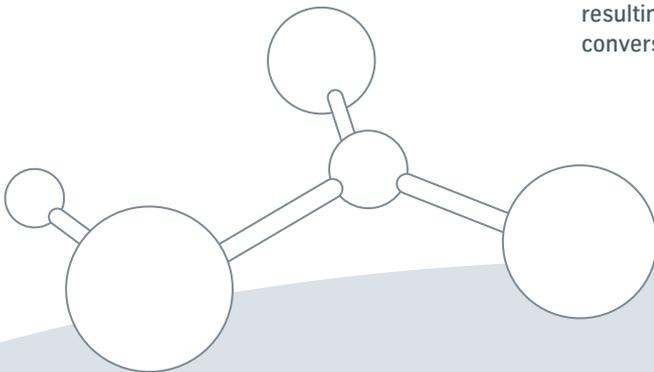


Features of thyssenkrupp nitric acid technology



Ammonia is mixed with atmospheric air and converted to nitrogen oxides over a platinum/rhodium catalyst. thyssenkrupp's proprietary ammonia burner design ensures an even distribution of reactants resulting in very high conversion efficiencies.

The heat of reaction is recovered by producing steam and heating tail gas. The hot tail gas and part of the steam are used in the turbines that drive the plant compressors, while the rest of the steam is exported.



thyssenkrupp Industrial Solutions, a market leader in nitric acid technology, have the longest experience in nitric acid as well as the largest reference list.

Whether your daily nitric acid requirement is for 20 or 2000 tons, thyssenkrupp can meet your needs with a highly efficient, economic, environmentally friendly plant which is tailored to your special situation. Nitric acid product concentrations are between around 60 wt.% typically for ammonium nitrate production, and 68 wt.%, the feedstock for organic syntheses which ultimately lead to such materials as soft and hard polyurethanes.

A plant can also be configured to produce both concentrations. thyssenkrupp's award-winning and BAT rated EnviNOx[®] system solves all current emission problems and future-proofs your plant against coming more stringent regulations. With its unrivalled N₂O and NO_x abatement performance EnviNOx[®] can also open opportunities for income generation in emissions trading systems, CO₂ tax regimes and the like.

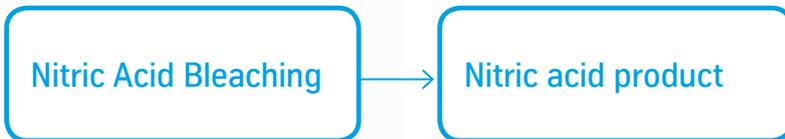
Friedrich Uhde, who founded the company that went on to become part of thyssenkrupp, cooperated with Wilhelm Ostwald to build the world's very first nitric acid plant using ammonia oxidation. Friedrich Uhde's pioneering work is honored in the name of our modern nitric acid processes: uhde[®].

The process gas is cooled below the condensation temperature and the first nitric acid forms. This is typically an area of high corrosion. thyssenkrupp's sophisticated acid condensation equipment avoids the conditions which promote corrosion, leading to longer life for cooler condensers and other heat exchangers.

Nitrogen oxides (NO and NO₂) are absorbed in water in a cooled absorption tower of proprietary thyssenkrupp design. The nitrogen oxides remaining in the tail gas are at a low concentration enhancing overall plant efficiency.

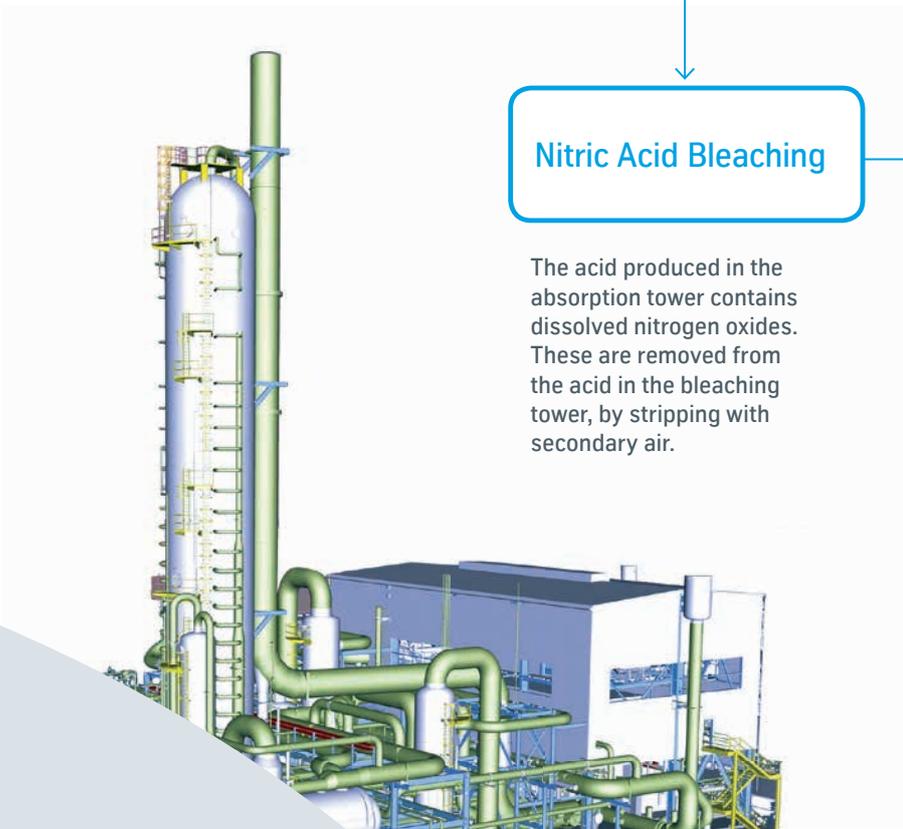
After absorption the remaining nitrogen oxides (NO_x and N₂O) are reduced to very low levels to meet the most stringent emission regulations. Even at plant start-up, typically a time of high emissions, an EnviNO_x® system can significantly cut unsightly brown stack plumes.

Clean tail gas



The acid produced in the absorption tower contains dissolved nitrogen oxides. These are removed from the acid in the bleaching tower, by stripping with secondary air.

Clean nitric acid product flows to storage or downstream plants.



Efficient, economic and environmentally friendly: thyssenkrupp Nitric Acid Plants

uhde[®] dual pressure nitric acid process

In a dual pressure plant each part of the process operates at its optimum condition:

- ⌚ Ammonia oxidation 4 – 6 bar
- ⌚ Absorption 10 – 14 bar

This maximises the overall plant efficiency in terms of low specific ammonia consumption and allows the plant to operate for long periods before the precious metal ammonia oxidation catalyst gauzes need to be changed.

Thanks to the EnviNOx[®] N₂O and NO_x abatement system the plant discharges very clean tail gas.

How you benefit:

The uhde[®] dual pressure nitric acid process has a range of special features which contribute to plant reliability, efficiency and flexibility, such as:

- ⌚ high efficiency ammonia burner
- ⌚ optimised heat recovery
- ⌚ corrosion-avoiding acid condensation system
- ⌚ patented seal gas system for nitrous gas compressor
- ⌚ range of nitric acid concentrations from typically 60 wt.% to 68 wt.%

uhde[®] dual pressure plant capacities start from around 500 t/day. The largest completely single train plants go up to 1600 t/day and higher capacities well over 2000 t/day are possible.



INEOS Köln
Cologne, Germany
Capacity:
1,500 t/day HNO₃ (100%)

High efficiency
for world-scale plants



CF Industries
Donaldsonville, Louisiana, USA
Capacity:
870 t/day HNO_3 (100%)

uhde[®] mono pressure nitric acid process

The ammonia oxidation and the absorption operate at the same pressure of 7 – 12 bar.

The result:
smaller equipment and pipe size and reduced equipment count leading to lower investment costs.

How you benefit:

All the special thyssenkrupp features are present in this design:

- ⊕ low investment
- ⊕ high efficiency ammonia burner
- ⊕ optimised heat recovery
- ⊕ corrosion-avoiding acid condensation system
- ⊕ high performance NO_x and N₂O abatement with EnviNO_x[®]
- ⊕ choice of product acid concentrations up to 67 wt.%, or two concentrations at the same time, such as 60 wt.% and 68 wt.%

The uhde[®] mono pressure nitric acid process comes into its own at capacities below about 500 t/day.



The ideal choice
for low capacities

Enaex S.A.
Mejillones, Chile
Capacity:
925 t/day HNO₃ (100%)



Thai Nitrate Company
Rayong, Thailand
Capacity: 210 t/day HNO_3 (100%)



uhde[®] azeotropic nitric acid process

While 60% nitric acid is usually required for fertilizer manufacture, the non-fertilizer industry demands higher concentrations. Nitric acid with a concentration of up to 68% can be produced with the uhde[®] azeotropic process. Among the special features which make this possible are:

- ⊕ drying of process air by nitric acid side stream to prevent dilution of product acid by atmospheric moisture
- ⊕ absorption tower performance improved by cooling with cold water chilled by plant ammonia feed evaporation
- ⊕ precise design to obtain high NO₂ partial pressure at process gas inlet of absorption tower

How you benefit:

The uhde[®] azeotropic nitric acid process incorporates all the special features which contribute to plant reliability, efficiency and flexibility, such as:

- ⊕ high efficiency ammonia burner
- ⊕ optimised heat recovery
- ⊕ corrosion-avoiding acid condensation system
- ⊕ patented seal gas system for nitrous gas compressor
- ⊕ very low emissions due to high performance NO_x and N₂O abatement with EnviNO_x[®]
- ⊕ product acid concentrations up to 68 wt.%
- ⊕ two different product acid concentrations at the same time, such as 68 wt.% and 60 wt.%

68 wt.% nitric acid
for the chemical
industry



EnviNOx[®] - the gold standard for N₂O and NOx abatement

The potent greenhouse gas nitrous oxide (N₂O) is formed in the ammonia burner as an unwanted side-product. The nitrous oxide passes through the rest of the nitric acid plant unchanged and is discharged to atmosphere with the tail gas. The tail gas also contains small amounts of other nitrogen oxides, NO and NO₂ (NOx) which are damaging for the environment and human health.

With an EnviNOx[®] system installed in the tail gas line upstream of the tail gas expander, NOx and N₂O emissions can be reduced to very low levels indeed. The technology is applicable over a wide range of tail gas temperatures.

Ammonia is used as a reducing agent for NOx, and N₂O is either catalytically decomposed, or reduced with a small amount of a hydrocarbon such as natural gas. NOx outlet concentrations of less than 1 ppm and 99% N₂O abatement rates can be achieved, making a nitric acid plant with EnviNOx[®] a very clean plant.

The NOx removal component of the EnviNOx[®] system can be installed separately if N₂O emissions are not yet an issue. An interesting option where additional flexibility is required is the EnviNOx[®] Ready system. The EnviNOx[®] reactor initially reduces NO_x but can be simply upgraded to also destroy N₂O at a later stage.

During start-up many nitric acid plants emit a brown stack plume, due to the high NOx concentration in the tail gas. A plant equipped with an EnviNOx[®] system can be tuned with the aid of tkIS' engineers to reduce NOx emissions before the light-off of the ammonia burner. The result is an invisible stack plume, even during this critical phase.

With more than 30 systems and a total cumulative greenhouse gas reduction of over 120 million t CO₂e, EnviNOx[®] technology continues to make a significant contribution to protecting the environment.

How you benefit:

- ⌚ unrivalled high abatement rates of N₂O and NOx
- ⌚ EnviNOx[®] system is in tail gas stream, thus no interference with nitric acid process
- ⌚ non-toxic catalyst materials simplify handling
- ⌚ works over a wide range of temperatures
- ⌚ can reduce NOx emissions even during start-up
- ⌚ abate NOx now and N₂O later when required, with an EnviNOx[®] Ready system
- ⌚ equally suited to new plants or as a retrofit to existing plants



For further details please refer to our separate EnviNOx[®] brochure.

Industrial Solutions

thyssenkrupp Industrial Solutions AG
Friedrich-Uhde-Straße 15
44141 Dortmund
Germany
T: +49 231 547 0
F: +49 231 547 10
nitrates@thyssenkrupp.com
www.thyssenkrupp-industrial-solutions.com

engineering.tomorrow.together.