

Industrial Solutions

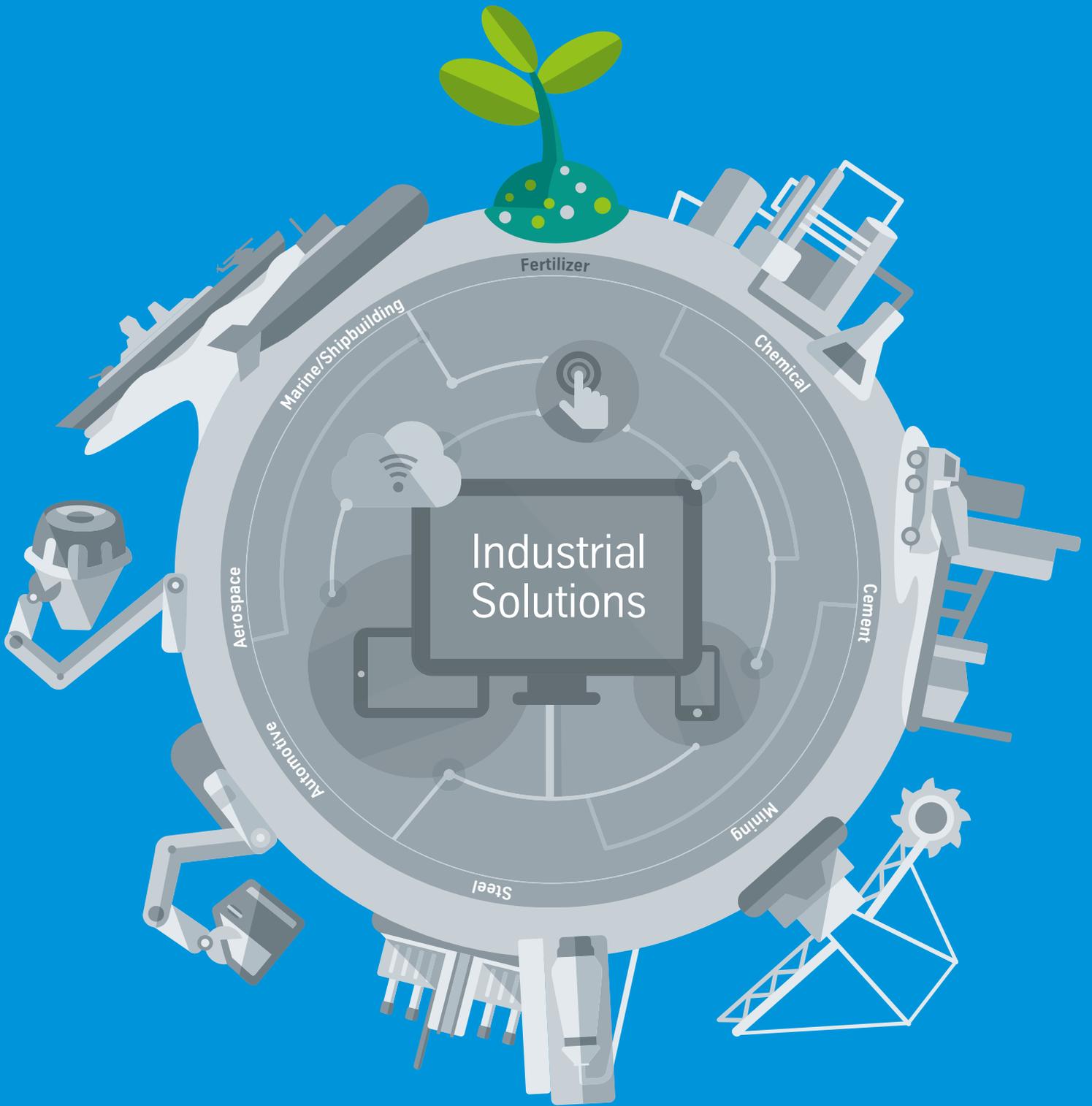
Fertilizers

Turnkey plants to grow
your business



thyssenkrupp





The power of true efficiency

The Business Area Industrial Solutions of thyssenkrupp is a world-leading engineering, construction, and service companies in the field of industrial plants and systems. Together with our customers, we develop solutions of the highest quality and deliver efficiency, reliability, and sustainability throughout the entire life cycle of their plants. Our global network, with around 19,000 employees at 70 locations, enables us to provide turnkey solutions worldwide, which set new benchmarks with their high productivity and, in particular, resource-conserving technologies. We are at home in

many different industries. Along with chemical, fertilizer, coking, refinery, cement, and other industrial plants, our portfolio also includes equipment for open-pit mining, ore processing, and transshipment, as well as associated services. In the naval sector, we are a leading global system supplier for submarines and surface vessels. As an important system partner to our customers in the automotive, aerospace, and battery industries, we optimize the value chain and improve performance.

Making you more competitive

As the amount of farmland declines worldwide, fertilizers are more important than ever in the efforts to feed a growing global population through improved agricultural productivity. But at the same time, the fertilizer industry is facing stricter environmental regulations, growing price pressures, keener competition, and the need to modernize production processes to enhance efficiency, boost productivity, and cut costs. With up to 90 years of global expertise and experience in plant engineering, procurement and construction, thyssenkrupp Industrial Solutions will not only help you meet these challenges but also deliver turnkey plant solutions that will grow your business. Our worldwide network enables us to serve as your competent partner for comprehensive concepts, pioneering engineering and reliable service. Our know-how and market knowledge will give you a competitive edge.

Contents

04	Three questions for...
06	Overview of our fertilizer processes
08	Overall competencies
10	Feedstocks
12	Ammonia
14	Urea
16	Phosphates
18	Nitric acid
20	Nitrates
22	Service

Range of products and services

Synthesis gas generation

- Steam reforming
- Autothermal reforming
- Combined autothermal reforming

Synthesis gas products

- Ammonia

Nitrogenous fertilizers

- Urea

Mineral acids

- Nitric acid
- N₂O/NO_x abatement (EnviNO_x®)
- Phosphoric acid

Nitrate fertilizers

- Ammonium nitrate/ CAN, UAN

Compound fertilizers

- DAP, NP, NPK

Granulation technologies

Services

Three questions for...



Dr. Dennis Lippmann,
Chief Technology Officer,
Fertilizer & Syngas Technologies
Business Unit

Three questions, three answers – Dr. Dennis Lippmann, Chief Technology Officer, Business Unit Fertilizer and Syngas Technologies provides a personal insight into the challenges of the fertilizer industry and of our work.

What challenges do you see in the fertilizer industry and how do you master them?

In general, the fertilizer industry is a growing business with sound underlying drivers like global population growth and a shift from vegetarian to more protein- and fruit-based diets in many parts of the world. However, like many commodity businesses, the fertilizer industry also faces investment cycles that are leading to oversupply and declining

product prices. This in turn results in phases of reduced investment until the general demand growth has absorbed the overcapacity or the most uncompetitive plants are closed down. In recent years, fertilizer capacity was added in excess of the actual demand growth and the resulting oversupply has put fertilizer producers around the globe under pressure to remain profitable at low product prices. thyssenkrupp Industrial Solutions is addressing this challenge by helping our customers to improve their operations with plant revamps to increase plant availability and lower a plant's energy consumption. Thanks to our team's extensive experience we not only focus on plants built by thyssenkrupp but also on ammonia and fertilizer plants from other technology licensors. From a technology licensor and EPC contractor point of view the challenge lies in the commoditization risk of this technology. Asian low-cost suppliers are offering standard technology that some customers consider acceptable despite lower performance and plant availability. For this reason, we are continuously investing significant amounts in R&D to stay ahead of the competition and offer the most advanced technology, while at the same time improving our cost position through smart value engineering without sacrificing plant availability.

What particularly characterizes your cooperation with your customers?

thyssenkrupp Industrial Solutions has the expertise and capability to address the full life cycle of plants. In many cases we are involved in early feasibility studies and scope definition; we participate in bidding projects and also develop projects together with the customer; we help to arrange financing for projects; we execute the engineering, procurement and construction, mostly as a general contractor on a lump-sum basis; and we do the operator training and commissioning assistance. Our service does not stop at handing over the commissioned plant either. Our expertise enables us to provide technical assistance during regular operation, engineer and implement upgrades and revamps for older plants, do turnaround planning and execution,

and also provide asset management for maintenance and operation, if a customer requires this. Thanks to our ability to provide such an extensive offering and the successful execution of past projects we have many repeat customers who also want to execute their next projects with us – sometimes even starting the next expansion phase before the previous project is finished. We believe that this kind of repeat business is a great testimony to customer satisfaction.

**And finally a personal question:
What do you find particularly fascinating
about your work at Industrial Solutions?**

As an engineer with heart and soul, I find the complexity of the ammonia and fertilizer technology as well as the sheer size of large-scale industrial plants fascinating in itself. For each project the boundary conditions are different and technology is constantly evolving so each plant is unique. Another interesting fact is that although the technology can be considered mature, we find new improvements every year through intensive R&D. This is only possible through support from thyssenkrupp, who invest a remarkable share of the

revenue in technology development. This is rather unusual for an EPC contractor and underlines the importance of technology leadership at thyssenkrupp. While many technologies are fascinating for the above-mentioned reasons, we should not forget that fertilizer technology is crucial for providing food security for an ever-increasing global population. Without fertilizer technology our planet could only have sustained 3 billion people.

“We help our customers to improve their operations with plant revamps to increase plant availability and lower a plant’s energy consumption.” Dr. Dennis Lippmann



Fertilizer complex for ENPC in Damietta, Egypt, with two ammonia plants and two urea plants with a total capacity of 2,400 mt/day ammonia, 3.850 mt/day urea. Industrial Solutions handed over the plants to ENPC in November 2016.

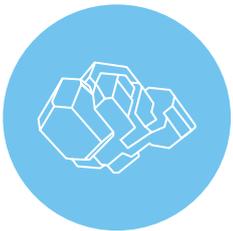
Feedstocks



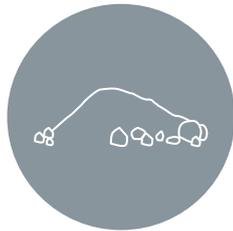
Energy
(natural gas, naphtha, coal,
biomass, hydrogen)



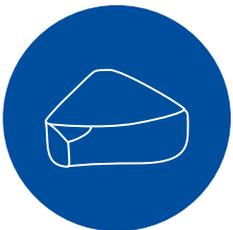
Limestone



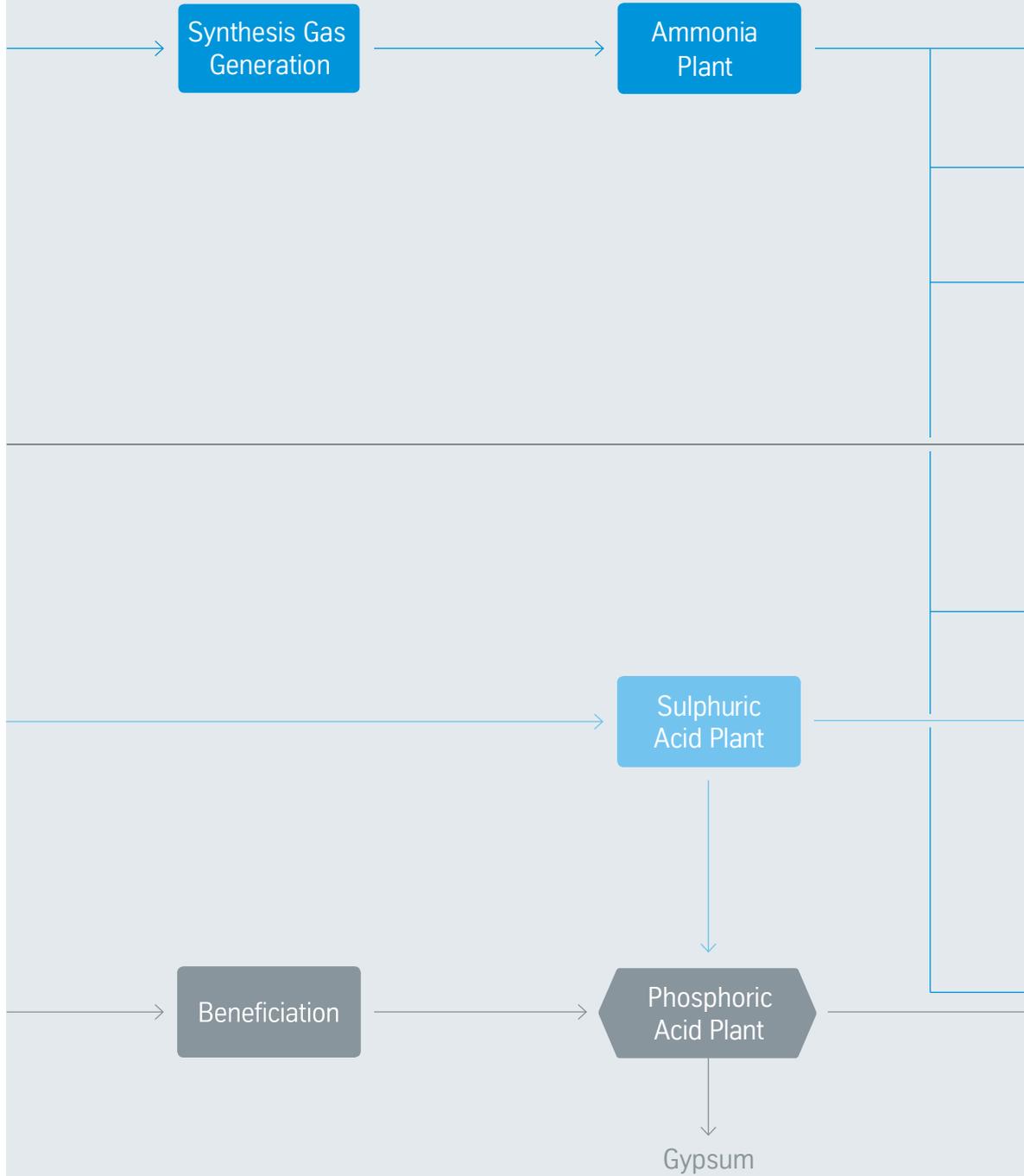
Sulphur



ROM Phosphate Rock

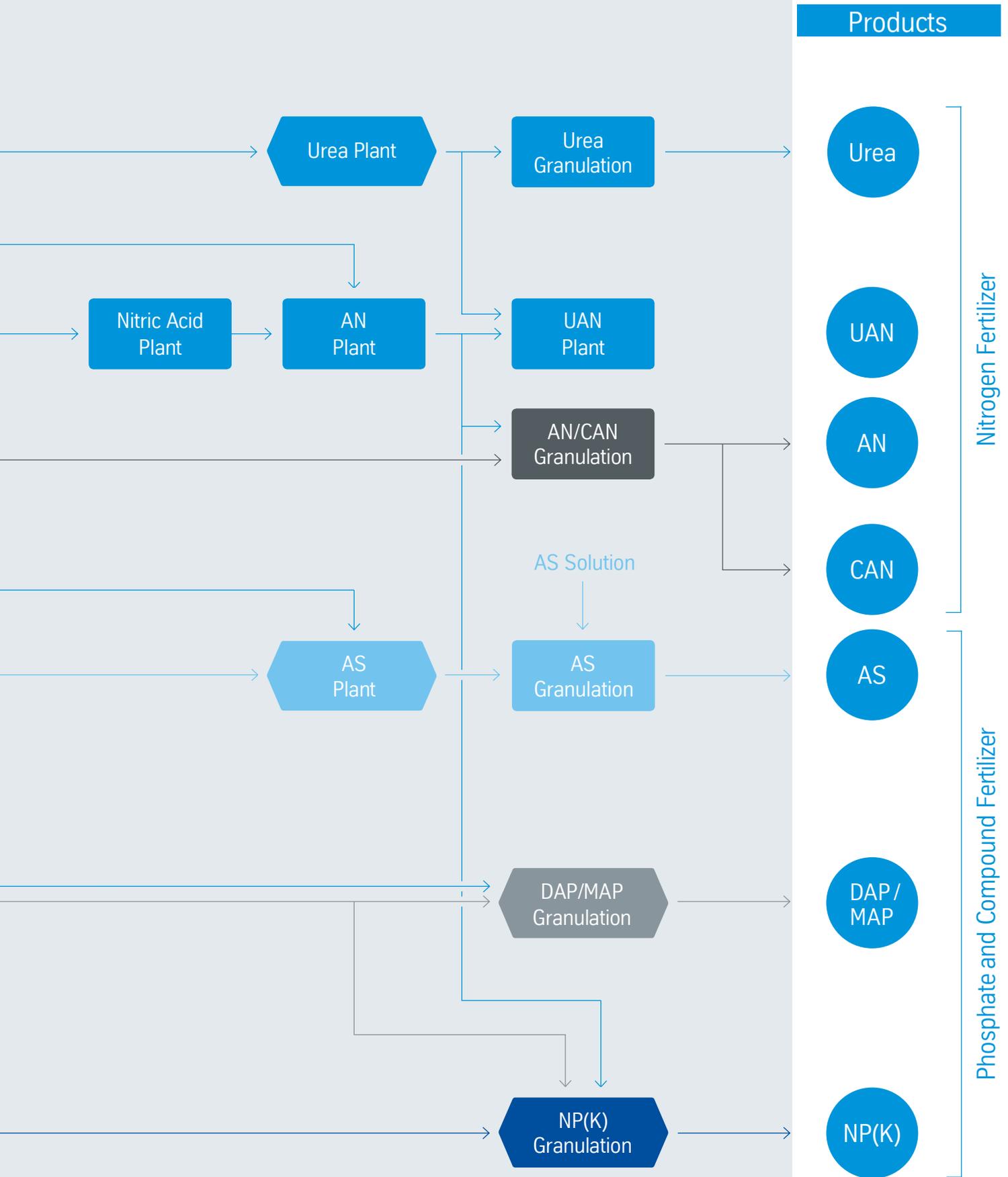


Potassium



■ = thyssenkrupp processes

■ = External processes





Global network, local presence

With decades of experience in the fertilizer market worldwide, thyssenkrupp Industrial Solutions has built up a worldwide network with powerful partners. This enables us to deliver the right solution for your plant and raw materials. You profit from a powerful globally operating company with a strong local presence.

Local market knowledge

From over 70 locations in six regions of the world, we offer local engineering competencies and capacities for numerous processes. That gives us an in-depth knowledge of your local requirements in the context of national rules and regulations as well as health, safety and environmental legislation. The fact that occupational health and safety is embedded in thyssenkrupp's mission statement reflects the top priority we give to this important issue.

**German engineering**

The German engineering skills on which our portfolio is grounded are realized in close collaboration with local partners, who work hand in hand with our teams to deliver the required services and cost-efficient solutions. And if a customer wants specific processes or services to be sourced in the country in question, we are always happy to comply with their wishes. That's German engineering on a global scale.

Full-line supplier

thyssenkrupp Industrial Solutions covers the entire fertilizer production chain with equipment, expertise and, in many cases, decades of cutting-edge Uhde expertise. What's more, our one-stop-shop solutions offer customers an extensive portfolio of logistics solutions, e.g. enabling fertilizer products to be transported from plant to port. As a full-line supplier, we offer a bunch of benefits, including optimizing every step of your value chain.

Mining know-how matters

Our business is to engineer and construct plants that enable you to efficiently turn feedstocks into raw materials for manufacturing fertilizers.

Mining and mineral processing

As one of the few full-line suppliers worldwide, thyssenkrupp Industrial Solutions produces innovative equipment and systems that enable raw materials to be mined in a reliable and resource-friendly manner. For phosphate fertilizers, for example, we are involved in the process chain right from the start as we manufacture the mining equipment for phosphate rock. In mining – excavating, conveying, spreading and dumping – and mineral processing – crushing, feeding, classifying, screening, separating, grinding, drying and filtering – our comprehensive capabilities ensure the best solution for every challenge.

Customized plant solutions

Thanks to our own technologies and licensed processes we can offer you the entire process chain for nitrogen and phosphate fertilizers. Since the products we deliver are customized to meet your specific requirements, you can be sure of a state-of-the-art turnkey solution.





Milestones in ammonia since 1928

From the first ammonia plant to use a Ude proprietary process that went on stream in Herne, Germany in 1928 with a capacity of 100 t/day to the 3,300 t/day plants so far built in Saudi Arabia and the USA, thyssenkrupp has repeatedly set standards in state-of-the-art ammonia plant engineering and construction.



100 mt/day: In 1928 the first ammonia plant started production for the Mont-Cenis Mine in Herne, Germany.



About 90 years
of turnkey EPC
solutions –
tailored to our
customers' needs.



3,300 mt/day: The ammonia complex for the Saudi Arabian Fertilizer Company (SAFCO) in Al Jubail, Saudi Arabia.



3,300 t/day

This Saudi Arabian ammonia plant is already the largest of its kind, and its capacity is to be increased by a further 11% in 2017.

reforming, coal and waste by Uhde coal gasification, and renewable energy by Uhde chlorine electrolysis; sulfur removal by the Uhde Claus and MDEA processes; CO₂ recovery from flue gas; and CO₂ removal by the BASF OASE white®, UOP (Benfield) or other processes.

The solutions we currently offer can cover all your possible requirements, with capacities ranging from 200 to 4,500 mt/day (tonnes/day), energy consumption as low as 6.4 Gcal/t, BAT emission-reduction facilities, ammonia plant revamps, as well as plant maintenance and operator training services.

The right process for every feedstock

In today's tough economic climate you want a turnkey, one-stop-shop plant solution offering the best available technology (BAT) and the highest possible uptime. We offer the right process for every feedstock through our own cutting-edge technologies and all relevant licensed processes: natural gas or Naphtha processed by Uhde steam

Tailored to your needs

We offer worldwide turnkey engineering, procurement and construction (EPC) solutions that are tailored to your needs. Along with first-class interface management, warranty compliance, high uptime levels and continuous support for operation and maintenance, this has distinguished us from the competition for around 90 years.

Unmatched in urea

With decades of experience in the engineering and construction of urea plants and an unmatched portfolio in this field, we can deliver precisely the urea plant you need.

Delivering BAT for maximum uptime

You are looking for a plant solution from a single source featuring the best available technology (BAT) and maximum uptime. We offer our own market-leading UFT fluid bed urea granulation technology as a cost-efficient, environment-friendly, state-of-the-art solution that is suitable for any site worldwide. In the past two decades we have designed and built no fewer than 19 new urea plants and revamped numerous more. Thanks to 40 years of partnership with Stamicarbon we can also offer their leading synthesis and prilling technology. Our comprehensive portfolio, which also includes other granulation technologies, is complemented by extensive know-how, service and training facilities that enable us to meet all your pre- and post-installation demands. Our turnkey EPC solutions offer production capacities of 600–5,000 mt/day along with state-of-the-art technologies to reduce ammonia and dust emissions.

3,500

mt/day urea solution





Turnkey engineering, procurement and construction (EPC) solutions for every kind of urea technology and customized to your requirements

Outstanding references

Europe's largest single-train urea plant with a nameplate capacity of 3,500 mt/day, a peak load of 4,200 mt/day and an actual performance of about 4,000 mt/day, built for Yara in Sluiskil in the Netherlands, is one of our top references. Other benchmarks in our long history as a full-service provider include the QAFCO 4 and SAFCO 4 plants in the Middle East, and the CFI plants in the USA, all with capacities above 3,000 mt/day, and with the latest BAT technologies installed at the CFI plants. Together with our licensing partner Shell we are also breaking new ground by providing urea-ES (enhanced sulfur) technology so you can supply your customers with the required product mix to ensure long-term sustainability and maximum yields in crop production.

Europe's largest urea plant at 3,500 mt/day – built in The Netherlands for Yara of Norway, the world's biggest urea producer.



More efficient and economical in phosphates

DAP granulation plant, GSFC India

We utilize our own and licensed technologies to deliver custom-designed phosphate plants that form the basis for the efficient and economical use of this vital raw material.

Better operational and environmental performance

Today's phosphates' market is marked by the construction of new plants, extensions to existing ones and replacement of older plants by new ones. Those new facilities have to run more efficiently and deliver an improved environmental performance. Our know-how enables us to custom-design your plant to meet these requirements as well as your specific needs. With licensed technologies from Prayon for phosphoric acid and Incro for ammonium phosphate neutralization and phosphate fertilizer granulation, as well as with our own equipment we are in a position to offer all-in facilities for the production of:

- Sulfuric acid
- Phosphoric acid
- Monoammonium phosphate (MAP)
- Diammonium phosphate (DAP)
- Nitrogen-phosphorus-potassium (NPK)
- Other phosphate-based fertilizers

Our portfolio is rounded off by studies, basic and detailed engineering, procurement, construction and commissioning, as well as services for performance improvement, operating and maintenance.

Solutions from start to finish

As a full-service provider, we assume entire and undivided responsibility for every step of the process chain and every phase of your project in order to deliver a turnkey, lump-sum solution. Our extensive expertise enables us to optimize all these process steps, and in particular the interface between beneficiation and phosphoric acid production by the Prayon process. When your plant is up and running, our comprehensive range of services will help to ensure its smooth operation.

Whatever the size of your project, we have the capacity to deliver what is required from start to finish, as illustrated by the DAP plant in India.

“Our know-how enables us to custom-design your plant to meet these requirements as well as your specific needs.”



DAP granulation plant for Gujarat State Fertilizer & Chemicals (GSFC) in India; capacity 1,320 mt/day.

Leading the field in nitric acid

With nearly 90 years of experience in nitric acid plants, thyssenkrupp Industrial Solutions is the global market leader in this technology with all the capabilities required to deliver highly efficient, compact and environmentally friendly plants.

Responding to market challenges

As overcapacity and low prices currently characterize the global market for nitric acid, plant operators are looking for favorably priced solutions offering interruption-free operability with minimal downtime and low emissions, constantly high product quality, low energy and raw material consumption, minimal maintenance, and seamless handling of an entire project. This is exactly what thyssenkrupp has to offer. Our extensive portfolio includes all the nitric acid technologies the market demands: mono medium-pressure, mono high-pressure and dual pressure acid processes. Mono processes are particularly suitable for small-capacity plants due to the low investment costs, whereas the dual-pressure process offers the lowest running costs. The breadth of our portfolio enables us to deliver precisely the turnkey EPC solution you need.





EnviNO_x[®]
reduces significantly
emissions
of NO₂/NO_x



Unique offering

We are a technology and EPC company with the capacities and expertise to offer the entire process chain of integrated nitrate fertilizer complexes, including auxiliary plants and ancillary facilities. In addition, our own award-winning EnviNO_x[®] reduces significantly emissions of “laughing gas” (NO₂/NO_x), a very harmful greenhouse gas. This enables us deliver a one-stop-shop turnkey solution that is fine-tuned to meet your precise requirements and supplemented by after-sales service and customized revamps. Since 2000 alone we have built 21 nitric acid plants worldwide. The latest, with a capacity of 1,200 mt/day, will be completed for Grodno Azot JSC, Belarus, in 2017.

Maximizing efficiency in nitrate production

With almost half a century of expertise in ammonium nitrate facilities, thyssenkrupp Industrial Solutions has developed its own process designs for all types of plants, including neutralization, urea-ammonium-nitrate (UAN), prilling and granulation facilities, as well as building plants on the basis of licensed technologies.



Minimal downtimes and low emissions

In a market currently suffering from overcapacity and low prices, the demand is for favorably priced solutions offering:

- Interruption-free operability with minimal downtime
- Low emissions
- Consistently high product quality
- Low energy and raw material consumption
- Minimal maintenance
- Seamless project handling

We can meet these market demands thanks to our broad range of nitrate technologies:

- Vacuum and pressure neutralization (with evaporation) for ammonium nitrate (AN) fertilizers
- Pugmill granulation for calcium ammonium nitrate (CAN) and AN fertilizers
- UAN for liquid fertilizers

And the plant solutions we offer are not just customized to your needs but also ensure optimized investment and running costs. Our extensive portfolio ranges from licensing, basic engineering and equipment deliveries to turnkey new plants (EPC) and revamps of existing facilities.



200.

2,000

mt/day

The key advantage of our ammonium nitrate pugmill granulation process is its flexibility in capacity



Market-leading nitrate technologies

Whichever nitrate technology you choose, you can be sure of a solution that brings you big benefits. The distinguishing features of our AN vacuum and pressure neutralization technology include a specially designed neutralizer, minimal nitrogen losses, a built-in exhaust vapor treatment system, the highest possible safety standards, and minimal maintenance costs. We have installed plants with a capacity of up to 2,100 mt/day. The key advantages of our CAN/AN pugmill granulation process is its flexibility in capacity (200–2,000 mt/day) and product terms, its tolerance of dolomite and limestone fillers, the easy addition of supplementary nutrients (S, Mg, etc.) and, not least, a hard, uniform product quality.

Our plant solution will be fine-tuned to meet your precise requirements, complemented by project financing support, and supplemented by after-sales service and customized revamps. A plant we completed for Nitrogénművek Zrt. in Pétfürdő, Hungary, in 2016 has an AN neutralization capacity of 1,515 mt/day and a pugmill granulation capacity of 1,960 mt/day for CAN (27% N) and 1,550 mt/day for AN (33.5% N).

A man wearing a blue hard hat and safety glasses is leaning over a desk, writing in a notebook with a blue pen. A desk lamp with a magnifying glass is positioned over the notebook, illuminating the work area. The background is dark and out of focus.

How we define service

Professional support is vital if complex plants are to run with minimal downtime and generate added value. We make running a complex plant easier by providing 360° support, which starts with the engineering of a plant and continues through commissioning and the commencement of operations right up to the end of a plant's working life. Our service portfolio provides all the relevant service products over a plant's entire lifecycle – all over the world. That's what we call 360° service.



360° support

Hand in hand with our customers, we implement a wide variety of projects and, thanks to our expertise and decades of experience, can ensure the successful erection of the most complex plants, even in difficult environments. And we don't stop there. All our customers, wherever they are in the world, can rely on thorough, fast and comprehensive support in operating and, if required, maintaining their plant – a service we also provide for plants from other manufacturers.

Tailored to your fertilizer needs

Our revamps, spare parts and asset management services are particularly relevant for fertilizer customers. As demands on your plant change over time, we can revamp it to improve uptime, optimize raw material use, lower energy consumption and ensure compliance with environmental standards. Forward-looking spare parts' management can also increase your plant's uptime and reduce operating expenses. Our asset management service is based on proactive maintenance, which helps reduce your total cost of ownership and boost plant performance. Our understanding of service is that we assume joint responsibility for your production – as true partners.

Globally networked infrastructure

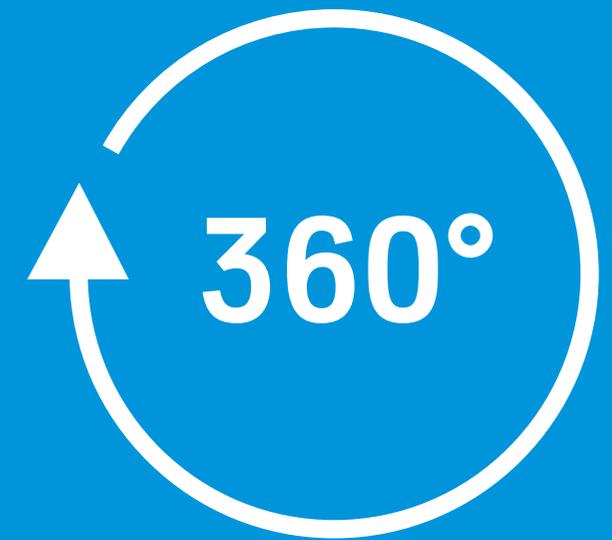
In servicing and maintenance work, our customers can fall back on a wealth of technical and business know-how supplied through our globally networked infrastructure. Our spare parts' management service ensures cost-effective parts and the fastest possible delivery – not least thanks to our online ordering system PSPN. The well-trained personnel at our local service centers have all the necessary know-how to lend a helping hand on site. Our specialists define optimum operating and service intervals, enhance your cost efficiency and equipment life through modernization and maintenance, and even handle relocation and decommissioning. And we work closely with our customers to adapt automation technology to their specific requirements. That's how we define service.

Save time when looking for spare parts

thyssenkrupp Industrial Solutions provides high-quality spare parts and extensive after-sales services.

The Service Product Finder on www.thyssenkrupp-industrial-solutions.com offers an overview of all our products.

Service from a single source



Asset Management



Revamps



Service Center & Field Services



Spare Parts' Supply & Management

Industrial Solutions
Fertilizer and Syngas Technologies

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