

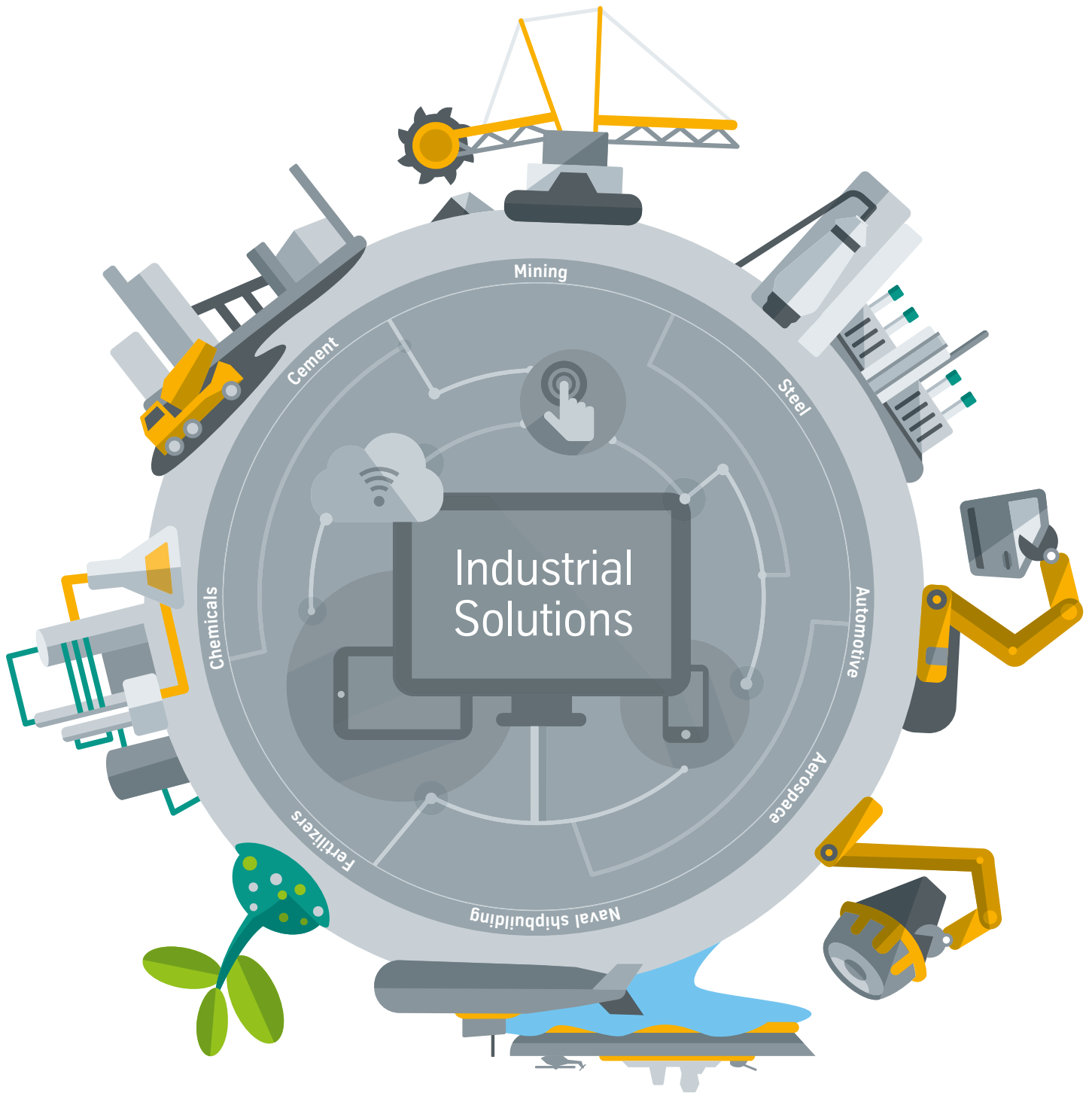
Industrial Solutions

360° Service for your plants



thyssenkrupp





The power of true efficiency

The Business Area Industrial Solutions of thyssenkrupp is a world-leading engineering, construction, and service company 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 your plants. Our global network, with around 21,000 employees at over 100 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 chemicals, fertilizers, 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.

The hidden gains of all-round service

Business costs are like an iceberg. Some are clearly visible, like the purchasing costs of equipment and materials, contractors' fees or personnel costs. Some are hidden – and those are the costs that can really hurt your business, like lost production through equipment downtime, reduced asset life and the serious damage to your reputation caused by safety or environmental risks, poor quality or delivery issues.

To ensure that our customers obtain the best possible performance from their plants and machines, we offer all-round service packages including parts, field services, workshop repairs, revamps, relocation and asset management to guarantee their expectations are met.

Our service solutions are defined around the impact on the customer's bottom line. For example, our asset management package can boost your bottom line by 2–10% through improving performance and reducing costs. Find out more about what services thyssenkrupp Industrial Solutions has to offer your industry on the following pages.

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Serving your industry

At thyssenkrupp Industrial Solutions we are at home in many industries. That's why we can offer each industry a dedicated 360° service package.

- Mining
- Steel
- Automotive
- Aerospace
- Naval shipbuilding
- Fertilizers
- Chemicals
- Cement

Three questions for ...



Three questions, three answers:
Dr. Donald Weir, CEO Business Unit Service, thyssenkrupp Industrial Solutions, outlines the distinguishing features of its service portfolio and the benefit it brings for our customers.

What range of services does thyssenkrupp Industrial Solutions offer?

After listening to the needs of our customers and their specific markets, we have developed a portfolio of services that can meet their individual requirements and exploits the economies of scale and industry knowledge we can provide from our global operations. We do not offer general all-purpose solutions but meet the specific needs of our customers individually. This means that if a customer needs a single spare part as fast as possible to end a breakdown of a critical machine, or wants to modernise their plant with a study followed by a project tailored to a turnaround schedule or to review their overall maintenance function – we can meet the need with technical experts who understand the specific issues of their industry.

Our portfolio optimizes our customers' profit and minimizes their risk, drawing on technical expertise with critical machines and processes, experience from years of providing service around the world and our on-going innovation program.

What is the difference between thyssenkrupp Industrial Solutions and competitors?

thyssenkrupp Industrial Solutions is a leading solution provider in the industries it serves. In addition to the economies of scale and process expertise this brings, our expert staff have gathered years of experience from around the world throughout the entire plant life cycle.

This scale and knowledge base provide a platform for the services to which we have added our investment in local service centers, customer oriented processes and technical experts. If a customer has a problem and needs to find a quality solution as quickly as possible, they can draw on our expertise whether this is on optimizing the entire plant or upgrading a specialist machine. We are able to fulfill these needs through our network of local service centers and our knowledge of the customer's industry.

thyssenkrupp Industrial Solutions has developed its leading position based on reliability, performance and innovation – these values continue to guide our approach today.

Why do customers trust thyssenkrupp Industrial Solutions?

Our focus is on optimizing our customers' profit and risk, i.e. developing a win-win solution.

thyssenkrupp Industrial Solutions offers continuous support and targets a sustainable relationship. As a reliable back-up and trusted partner for our customers, we continue to invest in infrastructure, expertise and services to enhance our customers' future.

>1,500
experts dedicated to service

Leading
OEM expertise
and service know-how

”Our focus is on optimizing our customer’s profit and risk – creating a win-win situation.”

70
locations
all around the world

Worldwide
service centers
for local overhaul,
refurbishment and
manufacturing



Parts & supply management

Spare parts supply | wear parts solutions | advanced parts solutions

A defective part can lead to unexpected and costly downtime. Forecasting the need for parts helps increase the reliability and availability of your plant, as well as reducing your overall operating expenses. We advise you on the correct time to replace components and which parts are suitable, deliver and fit the parts, ensure high quality and rapid availability, and supply an electronic catalog to save you time and effort in finding the right parts. In addition to optimizing your parts' supply and management, we also assist in streamlining your warehousing processes.



Field & workshop services

Technical inspections | repairs and field support | workshop services | operator & maintenance training courses

Anywhere in the world we can apply our specific plant know-how as your local service partner. Thanks to our network of service centers and local workshops, we offer fast assistance when you need it most – in overhauling strategic parts, maintenance or servicing. By detecting and eliminating problems early, we increase your plant uptime. Our custom recommendations for maintenance and modernization help you to precisely plan plant stoppages. Moreover, we offer training courses and seminars to keep your staff up to date and safe.



Revamps & outages

Analysis, engineering and manufacturing | plant improvements | revamps execution up to EPC | turnaround management

Over the course of time, the demands placed on production plants may well change. In order to meet these changing demands, we offer you services in the fields of revamps and retrofitting, debottlenecking and capacity expansion, emission reduction, efficiency enhancement, converter revamping, and outages. When we implement such a revamp or upgrade, plant stoppages are minimized and the outcome brings benefits such as improved uptime, optimal raw material use, lower energy consumption, and compliance with stricter environmental standards.



Asset management

Consulting & audits | technical guidance | operation & maintenance contracts

At thyssenkrupp we assume joint responsibility as true partners for your production, including the risks involved. Thanks to our many years of experience in the field of plant engineering, we can help to optimize plant availability and minimize maintenance costs. Since our asset management is based on proactive maintenance, it helps to reduce your total cost of ownership by lowering your operating expenses, and boosting reliability and performance, thereby increasing the profitability of your plant.



We deliver service solutions along the entire plant life cycle to enhance our customers' competitiveness. **That's what we call 360° Service.**



- thyssenkrupp Industrial Solutions locations
- Headquarters, Essen, Germany



Boosting your output through rejuvenating equipment

Customers in the mining industry take advantage of the broad base of experience and knowledge of thyssenkrupp Industrial Solutions. The company offers local upgrades and refurbishments by utilizing the know-how of its workshop network and field service teams.

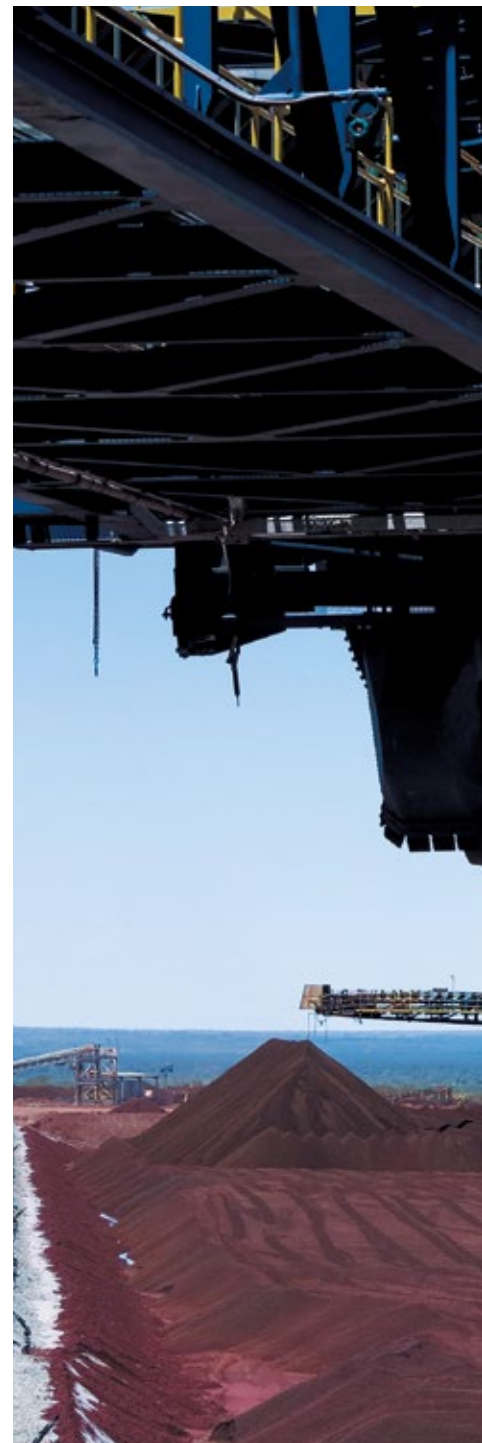
Life cycle extension through refurbishment of giant bucket wheel excavator in Germany

After more than 50 years of operation the bucket wheel excavator at an open cast lignite mine in Germany needed an extensive technological upgrade to prolong its service life for another decade. The task involved, among other things, fitting a new bucket wheel head with a new bucket wheel, reconstructing the bucket wheel boom conveyor system, redesigning the driver cabs, and replacing the tensioning and hoist ropes. The challenge was to integrate state-of-the-art technology into an old excavator – and deal with any unexpected surprises that often crop up with aged equipment. As a result, the bucket wheel excavator is in service again with an increased availability while the costs of maintenance, repair and stocking of spare parts were cut by 5%.

Maintenance of reclaimer in just six days at iron ore mine in Western Australia

The deadline for conducting the complete shutdown maintenance of a 15,000 tph balanced bucket wheel reclaimer in Australia was as challenging as the installation's remote location in the Western Australian outback. The logistics and information flow for data collection were additionally challenging features of a maintenance project that involved procedural welding, pulley changes, and drive alignments. In just six days the machine was returned to service with the maintenance work completed to a high standard of workmanship and ahead of schedule. Even more importantly, all the required tasks were performed safely with no LTIs or procedural breaches.

Service life
extended
by **10 years**



Machine
back in
service in

6 days

**11% increase in daily output through
revamping overland conveyors at
copper mine in Chile**

Two overland conveyors at a copper and molybdenum concentrate mine were suffering from drive failures and vibration issues. The problems such as excessive belt sag at the tail, unexpected braking, structural, mechanical and control instrument issues led to a below-par transport capacity. thyssenkrupp was asked to lead the project with multiple stakeholders in extreme conditions at an altitude of 5,000 meters above sea level where sub-zero temperatures are common. The customer's goal was to increase the productive capacity from 8,500 to 10,500 tph and recuperate a reliable system. To boost productivity dynamic winches and backstops were added, and a new control logic system for efficient operation was implemented. All this was achieved in just 12 days and the customer is now benefiting from an 11% increase in output from 139 to 155 ktpd.

**11% increase
in daily output**





Minimizing your coke plant downtime

When problems crop up in your coke production, you want help fast to minimize downtimes. thyssenkrupp Industrial Solutions has unparalleled experience and expertise in repairing and servicing coke plants, ensuring yours will be up and running as fast as possible.

Reduced risk of production outages at coke plant in Turkey

Numerous heating wall heads at a coke plant built in 1964 had to be repaired to reduce the risk of production downtime. A team of four thyssenkrupp specialists were involved in the planning and engineering phase; five technicians worked in shifts for over five months carrying out the repairs on site. They not only repaired the heating wall heads to the customer's full satisfaction but also came up with suggestions for preventive repairs and process improvements they identified while on site. As a result of the repair work, the risk of production outages was minimized and productivity significantly increased.

Productivity
significantly
increased



Normal operations reliably restored at coke plant in Germany

After incorrectly processed coal prevented coke being charged in 46 ovens of a coke plant in Germany, thyssenkrupp technicians were called in to help solve the problem. To avoid any overheating of the regenerators, special measures were taken to cool them down. After 880 hours of painstaking work the solid coke had been finally removed from all the affected ovens. The ovens were checked for any further damage and then returned to normal operation.

First coke pushed two months after severe earthquake

Rapid return to service of earthquake-damaged coke plant in Chile

In February 2010 an 8.8 magnitude earthquake badly damaged the 58-oven battery of a coke plant in Chile – Steel structures and pipes bent or broken, hydraulics and electrics non-operational, gas, water and steam supplies interrupted. The coke ovens could not be fired for 20 hours after the earthquake. thyssenkrupp had built this coke oven and was asked for its support for the repair work. thyssenkrupp technicians discovered one of the biggest problems was the damaged charging car, which was repaired in the shortest possible time. Initial attempts to restart the battery proved unsuccessful but the technicians discovered the cause of the problem – a pipe three-quarters blocked with tar. Just two months after the earthquake, the first oven was filled and the first coke pushed a day later.



46 ovens
brought back
into operation



Enhancing service through customer-centric improvements

Automotive OEMs are benefiting from the ongoing service improvements thyssenkrupp Industrial Solutions is introducing in this field. Two such examples are the dedicated service center in Győr, Hungary, and an e-learning program for customers and its own service personnel.

Increased service offering from strategic site in Hungary

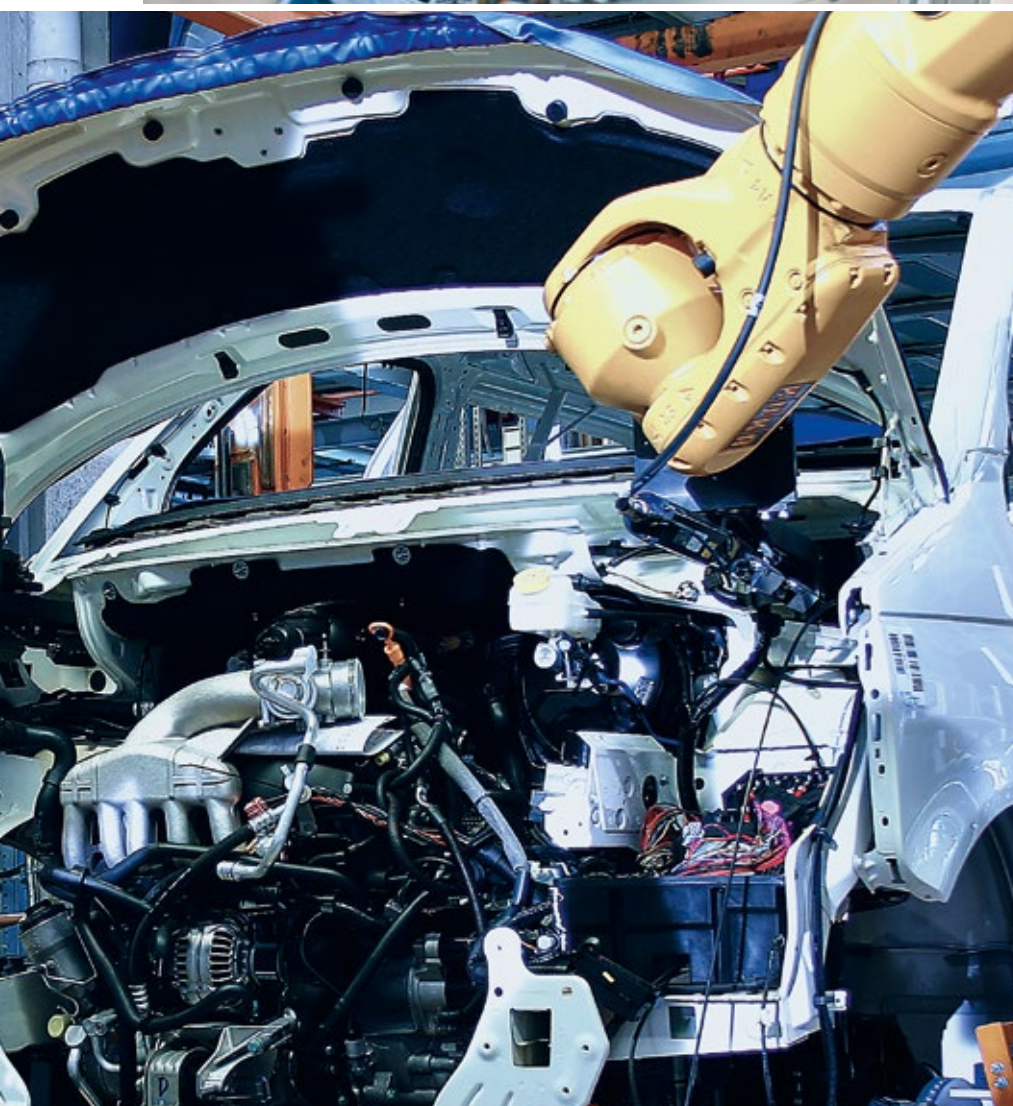
In October 2013 thyssenkrupp upgraded the small service facility at the Audi plant in Győr, Hungary, to a full service and production center. The location is of great strategic significance for Europe's automotive industry as over 3 million vehicles a year are manufactured at plants in the Czech Republic, Slovakia and Hungary – all within easy driving distance of Győr. The thyssenkrupp team offers a wide range of system engineering, production and maintenance services to Audi and other automotive OEMs. The benefits the services bring include lower project and service costs, fewer human interfaces, shorter delivery times, time savings, greater flexibility for last-minute modifications, and sustainable quality assurance.

Time savings through “one face to the customer”





Customized
training
content
**optimally
delivered**



**e-learning implemented
to upgrade service skills**

e-learning has many advantages over traditional teaching methods, above all in the freedom to learn wherever and whenever is most suitable for the program participant. It is also an economically attractive alternative to in person training sessions for standard processes and products. The technical e-learning program thyssenkrupp has introduced for its own service technicians and customers' maintenance personnel includes several modules of relevance to automotive OEMs: Noise, Vibration, Harshness (NVH) Measurements in Cold Test; Basics of Screwing Technology 1 & 2; Maintenance of the Friction Roller Conveyor Transport System; and ups64 Runtime Manager. These e-learning modules are proving beneficial in enhancing the skills of both thyssenkrupp service personnel and the maintenance personnel of automotive customers.



Maintaining your high-flying production

Preventive maintenance, production support, process optimization, consulting services: whatever your aerospace service needs, thyssenkrupp Industrial Solutions can meet them and deliver added value in doing so.



Implementing Industry 4.0

1,700

drilling & riveting operations
per part

Minimizing downtime and enabling cost savings

Keeping a high-precision assembly line for A320 wing parts up and running is a challenging task and vitally important. In an aerospace plant in Scotland four robot cells conduct around 1,700 drilling and riveting operations per part in a 12-hour cycle and over 150 structures a month. thyssenkrupp technicians continuously monitor the assembly operation to ensure the customer enjoys optimized levels of uptime. Further south in the UK, at a plant in Gloucester, thyssenkrupp technicians also carry out regular preventive maintenance work on a semi-automated assembly line for A330 and A350 landing gear. Here, the single harmonized assembly line developed and installed by thyssenkrupp is delivering both non-recurring and recurring cost savings through the implementation of lean manufacturing best practices. All the way from the design stage to after-sales service thyssenkrupp is helping this aerospace customer to maintain high-flying production processes.

“Concentrate on your core business, we’ll look after the rest”

A Russian aircraft manufacturer wanted to build a new assembly plant for a medium-haul commercial aircraft in Western Europe. thyssenkrupp’s broad and in-depth knowledge of the European aircraft manufacturing market and excellent relationships with research institutes led to it being commissioned with the search for potential sites. This enabled the customer to concentrate on its core business of planning the aircraft production process and building planes.

Walking the talk about Industry 4.0

Nowadays, everybody is talking about Industry 4.0, or the fourth industrial revolution as it is often called. thyssenkrupp is walking the talk. Various manufacturing execution system (MES) modules are currently being implemented as part of a large-scale turnkey project for an aircraft component manufacturer in North Germany. All the way from the initial concept to complete installation of this production line, thyssenkrupp is delivering an MES that enables all the production processes to be displayed electronically. The modules are processing quality, assembly and machine data to provide the customer with a fully transparent and predictable production environment as a key component of Industry 4.0.



Maximizing your vessel availability

Declining naval budgets, extended life expectancy of surface vessels and submarines, demanding maintenance requirements of highly sophisticated systems and equipment, brand-new technologies: navies the world over are facing huge challenges in maintaining the effectiveness of their fleets. thyssenkrupp provides customized solutions through In-Service Support.

Tailored solutions for your in-service needs

The innovative, flexible and multifaceted In-Service Support (ISS) program enables naval customers to maintain the highest possible operational availability of their surface vessels and submarines in the most cost-effective fashion. ISS is a modular solution that allows the customer to select comprehensive all-round packages or tailored individual solutions from a

wide-ranging portfolio covering asset management, spare parts' supply and management, engineering, training and consulting, service center and field services, and revamps and relocation. The key preconditions for maximizing operational availability are appropriate Planned Maintenance (PM) and Corrective Maintenance (CM) activities, which are normally part of the tailored ISS packages agreed with customers.

**Comprehensive
logistic back-up –
worldwide**







Racing against the clock to get your job done

When fertilizer plants need servicing or key components replacing, it is usually a race against the clock. When unexpected challenges crop up, teams from thyssenkrupp Industrial Solutions bring a can-do attitude to the job, as these examples show.

Rapid replacement of ammonia converter cartridge in South Africa

An ammonia plant had been running in South Africa since 1993 and key components needed replacing. As the customer did not have the necessary experience, thyssenkrupp Industrial Solutions was commissioned to carry out the ammonia converter cartridge replacement. The biggest benefits for the customer were a single-source solution for the entire project, and the willingness of the thyssenkrupp team to go the extra mile. They not only met but often exceeded the customer's expectations, e.g. by employing a dense loading technique to fill the reactor extremely quickly. thyssenkrupp's 24/7 service enabled the project to be completed in just four weeks.

Finnish hydrogen plant back in service on schedule

Worn heat exchangers in the convection zone and a feed steam inlet manifold had to be replaced in a hydrogen plant at a Finnish oil refinery. The biggest challenge was to complete delivery within nine months by the next planned refinery shutdown, even though the relevant parts usually took 12 months to deliver. When the job was finally

confirmed, only five months were left until shutdown. But thanks to thyssenkrupp's long-standing and close cooperation with the parts' manufacturers and their flexible response the parts were produced ahead of schedule. Though transporting the parts by road and sea from Germany and Austria to Finland was a logistical challenge due to their length, height and weight, they were delivered on time and the refinery began operating again on schedule.

Challenging upgrade of U.S. nitric acid plant

A U.S. fertilizer manufacturer and distributor requested an upgrade and capacity extension for a nitric acid plant. The task seemed impossible because of limited cooling water conditions and an extremely tight timeline, but thyssenkrupp came up with a solution that included replacing the absorption tower and cooler condenser. Although the job was all the more challenging as the materials in the cooler condenser were subject to extremely high stress factors, a suitable solution was again found: installation of a zirconium NO gas pre-cooler to protect the cooler condenser. An unexpected complication arose when the cooler condenser supplier reported problems procuring material for the shell. thyssenkrupp solved this problem in direct discussion with the material supplier. As a result, the 55-meter absorption tower, cooler condenser and NO gas pre-cooler were all delivered on schedule and the equipment was installed during a three-month plant shutdown and test operations were successfully completed on time.

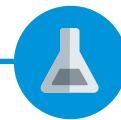
Reliable completion of complex projects



Refinery
modernized in
record time

Job completed
in 4 weeks





Enabling time and cost savings on complex projects

If your complex chemical plant needs revamping, key components have to be replaced or full-service remembraning is required, thyssenkrupp Industrial Solutions has the expertise and experience to save you time and money, even on complex projects.

Reconstructing a German olefin plant on time and below budget

A fire damaged the critical olefin plant at an oil refinery in Germany. The customer wanted it back in production as soon as possible with no lost-time incidents. The thyssenkrupp team put in a million working hours without a single incident despite the 1:1 reconstruction work being carried out under extremely cramped conditions. The reconstruction of plant was completed on time and below budget.

Beneficial revamping of U.S. plant

A US company wanted to switch from production with liquid DMT to the more competitive powder PTA. The revamp operation involved designing the new process, replacing four old reactors with one ESPREE® light reactor (patented, manufactured and delivered by thyssenkrupp), delivery of a wide variety of equipment and valves, integration into the existing production facilities, supervision of installation, and commissioning of the plant. In only four months the new plant was erected right next to the existing facility

without production being interrupted. The revamp gave the customer a more competitive process, improved product viscosity, and significant energy savings from the single-source engineering and equipment solution.

Spare parts for Dutch PA-6 plant delivered ahead of schedule

The order for replacement of two granulate coolers arrived in late January. The plant was due to shut down in early June. The usual delivery period for granulate coolers was around five months. An added complication arose when a systematic defect was discovered in the duplex pipes for the granulate cooler. The pipes had to be reordered. But despite that, the granulate coolers were delivered earlier than the tight schedule demanded in the last week of May.



1 million
working hours –
no incidents



New plant erected in four months

Re-membrating of electrolyzer elements in German plant

The re-membrating of 272 elements in three electrolyzers had to be completed within a three-week shutdown of a chlor-alkali electrolysis plant. The complex job was planned, engineered and conducted ahead of schedule thanks to the expertise and experience thyssenkrupp Industrial Solutions has gained over many years in full-service re-membrating.

Modernization of cracking furnaces in challenging conditions, Russia

Replacing the cracking furnace of a 30-year-old vinyl chloride monomer (VCM) plant in Russia was an extremely challenging task. The furnace had to be designed to withstand ambient temperatures as low as -50°C and design temperatures up to 650°C , and during their work the construction and commissioning team was faced with temperatures as low as -30°C . Nevertheless, building on decades of experience in planning, constructing and operating such plants, thyssenkrupp was able to install state-of-the-art cracking technology to modernize the plant, and completed the job on time with minimal downtime and in full compliance with the latest Russian GOST standards.



272

elements completed
in three weeks



Modernizing maintenance brings competitive advantage

Turnkey maintenance solutions bring customers a clear competitive advantage through benefits such as enhanced efficiency and energy savings.

Beneficial upgrading of pozzolanic cement mill in Mexico

After a regular inspection of a pozzolanic cement mill revealed that the hydraulic turbo coupling was damaged, the mill operator decided to modernize the power train by replacing the hydraulic turbo coupling and installing an asynchronous motor instead of the synchronous one. The thyssenkrupp experts in Mexico worked with their colleagues in Germany in one team. In close collaboration with a motor supplier they came up with a comprehensive solution for a completely new power train, which was no more



Maintenance efforts reduced – energy saved

expensive than purchasing replacement parts for the turbo coupling – and the delivery time was shorter. The German/Mexican team provided engineering, materials, and assembly, and commissioned the equipment. The benefits for the mill operator included higher levels of efficiency and resource utilization, energy savings, and reduced maintenance.

**Shells of Greek
three-station kiln replaced fast**

Initially, this job involved preparation and supervision of replacement parts for a cement plant kiln. thyssenkrupp Industrial Solutions won the contract by proposing the added value of a turnkey maintenance solution, commitment to an extremely tight schedule (only 26 days, stoppage) and provision of a two-shift, 10-man team. The work involved replacing two shell sections, reversing the pinion and girth gear, replacing spring plates, and aligning and commissioning the kiln. The site was prepared in just ten days, mobilized (incl. sub-contractors) in one week, and the job completed on time without any accidents. This turnkey maintenance solution was only possible within such a tight schedule because of thyssenkrupp's high level of kiln mechanics know-how.

Only
26 days
stoppage – no incidents

Service solutions throughout the entire life cycle of your plant



Parts & supply management



Field & workshop services



Revamps & outages



Asset management

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