

# Coke Plant Technologies

Pioneering coke plant technologies are part of our daily business. The efficiency and environmental performance of our plants are renowned worldwide. Tailor made complete coke oven plants from a single source – that's our commitment and your advantage gained from a partnership with us.

Engineering  
Excellence **3**

# 500

coking plants worldwide

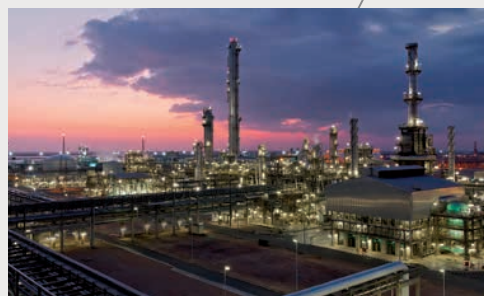


ThyssenKrupp  
Industrial Solutions



ThyssenKrupp





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# Engineering Excellence<sup>3</sup> – Think globally, act locally



Having erected several thousand plants, ThyssenKrupp Industrial Solutions is one of the world's leading engineering companies. Our Business Unit Process Technologies supplies chemical plants, refineries and coking plants on the basis of tried-and-tested technologies made by Uhde, while the portfolio of the Business Unit Resource Technologies comprises complete cement plants and grinding systems of the Polysius brand, as well as machines, plants and systems for mining, extraction, preparation, processing or transshipment of commodities.

With many years of experience in the EPC business, we offer our customers concepts, market studies, plant layouts, design engineering, supplies, manufacturing services, erection and commissioning – all from a single source. Our employees on all continents use their knowledge and engineering competence to create innovative solutions and to look for ways to conserve natural resources.

Over 40 locations in 25 countries – divided into six regions – form a close-meshed network that allows us to align our services to local conditions consistently. Thanks to this on-site expertise and global networking, we are able to set standards that offer our customers a true competitive edge.

Our comprehensive service concepts take the entire life cycle of a plant into account. We offer OEM spare parts service and complete maintenance management, as well as servicing, modernisation projects and conversions.





## 2. Competence and know-how by tradition

### A global leader for more than 130 years



"Zeche Holland" coke plant  
in the Ruhr area, Germany, 1895

ThyssenKrupp Industrial Solutions is proud to offer Uhde's coke plant technologies comprising the entire range of technologies and know-how from the most famous names in coke plant engineering.

The origin of the division can be traced back to the company Dr. C. Otto & Comp. which was founded in the year 1872. Carl Still and Heinrich Koppers, both employed as junior engineers by Dr. C. Otto, then formed their own companies in

1898 and 1901, respectively, and enjoyed great success for many decades. In the 70's and 80's the companies founded by these cokemaking pioneers were taken over by the groups Krupp (Koppers) and Thyssen (Still, Otto and Didier). Ultimately, the merger of the groups Thyssen and Krupp resulted in the combination of all coke-making technology activities into ThyssenKrupp EnCoke GmbH in 1999, followed by the integration into Uhde GmbH.



Dr. C. Otto



Heinrich Koppers



Carl Still



"Kwangyang" coke plant,  
South Korea, 1992



Integrated now into ThyssenKrupp Industrial Solutions', group for Coke Plant technologies with the global spectrum of activities has assumed the task of continuous improvements, building on the decades of accumulated know-how and maintaining the tradition of quality established by its founders.

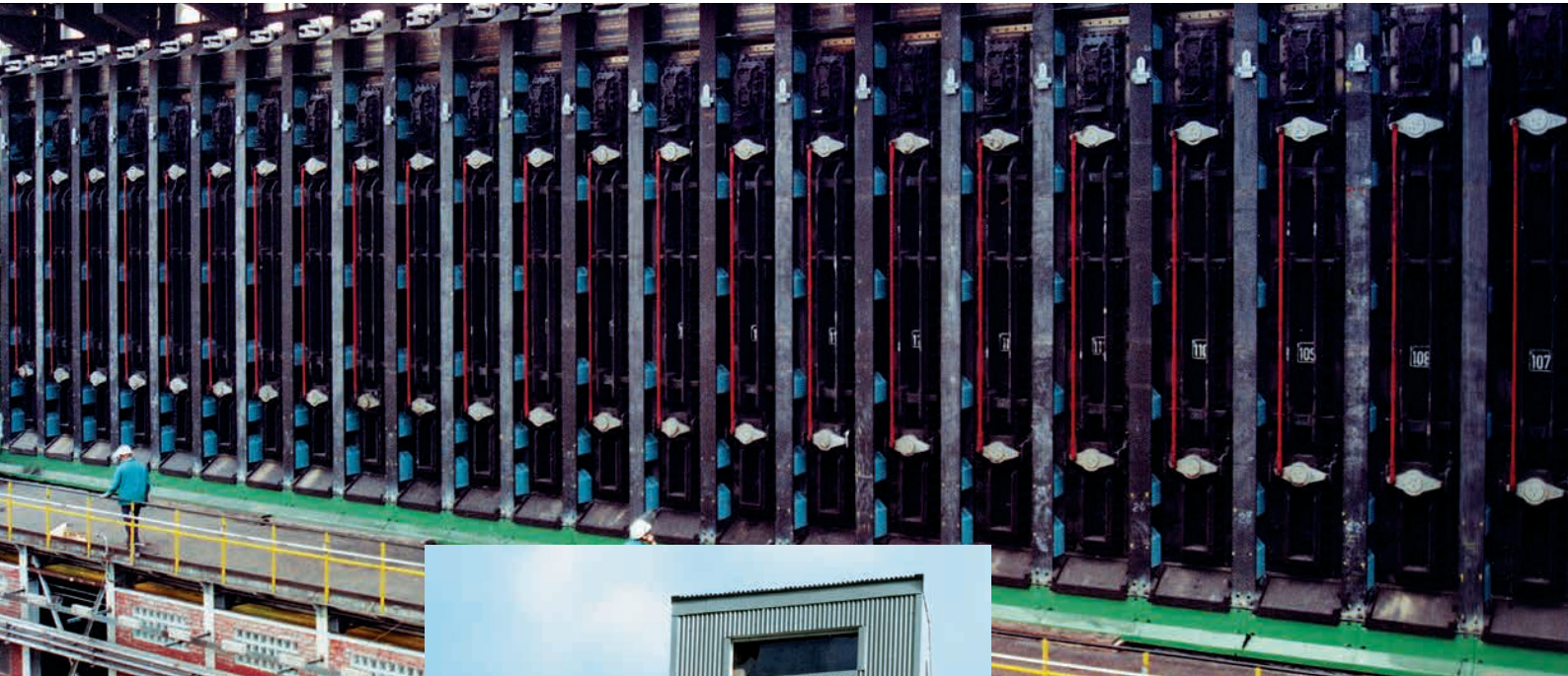
With state-of-the-art technologies and know-how proven through the construction of over 100,000 coke ovens and associated gas treatment facilities and service machines worldwide, ThyssenKrupp Industrial Solutions offers its customers a palette of systems and processes from which the optimum solution to their operational requirements can be provided. Along with know-how and experience in building new coke plants, we have a long and successful history of providing comprehensive technologies for modernising and repairing entire plants or individual plant components and work jointly with the customer to develop the most cost-effective solution to satisfy specific needs.





### 3. Slot-type coke oven batteries

More than 100,000 times worldwide



Battery front of 8.4 m ovens at the Schwelgern coke plant, Germany



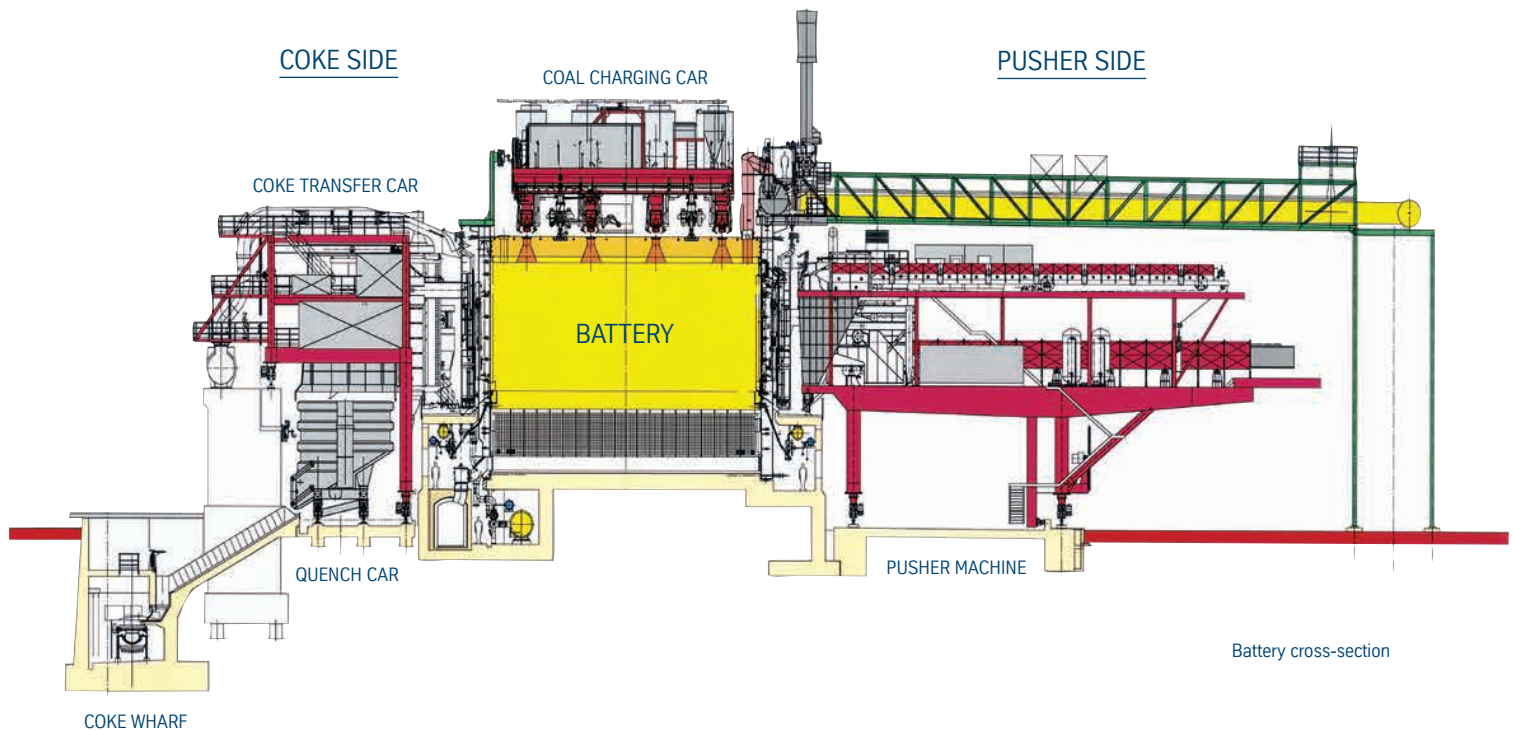
GLD, Detroit, USA

ThyssenKrupp Industrial Solutions has been designing and building coke oven plants for more than 130 years, making it the longest established coke plant engineering company in the world. Our competence and know-how – gained through the construction of more than 100,000 coke ovens worldwide – are embodied in numerous inventions and developments which are today recognised standards in modern cokemaking technology: for example multi-stage heating. ThyssenKrupp Industrial Solutions has always been a front runner in the technical development of coke oven plants.

Among these inventions and developments are the principle of regenerative heating, the introduction of compound ovens and the gradual enlargement in chamber height to well over 8 m and in oven volume to over 90 m<sup>3</sup>.

Linked to an increase in the net volume of oven chambers, the oven width has also been expanded from the conventional 450 mm to typically 590 mm. This development began in the mid-80s and has become a technically matured solution. Fewer production cycles per day and oven, accompanied by higher shrinkage values of the coal, result in a major reduction in thermal and mechanical stresses,



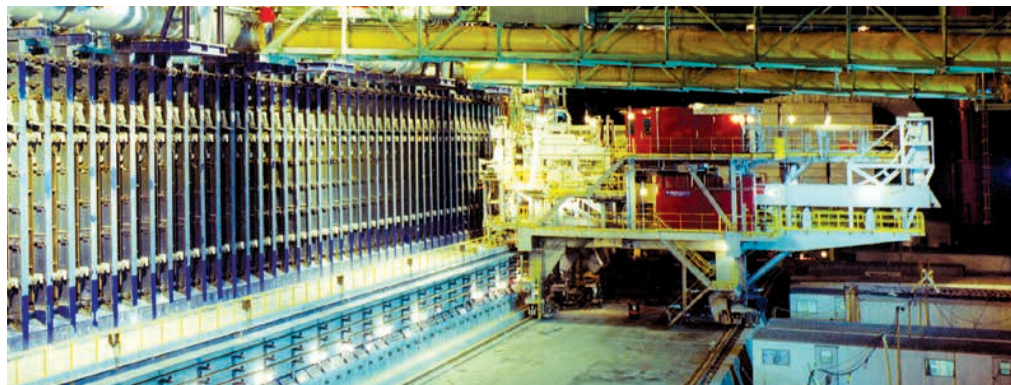


which helps to protect the battery structure and prolong its lifetime.

The principle of multi-stage heating – nowadays standard technology for heating coke ovens – was introduced by Carl Still as early as 1926. ThyssenKrupp Industrial Solutions can now supply the optimum heating concept to meet any specific demand: COMBIFLAME® and TWINFLUE for compound ovens of either the gun-flue or underjet type, and MULTISTAGE for purely rich gas ovens.

The increasing heights of oven chambers and the associated stability requirements for maintaining the refractory materials demand fully effective oven bracing systems. Over the course of approximately 30 years ThyssenKrupp Industrial Solutions has developed the CONTROLPRESS® system based on intensive research and development, accompanied by data from practical experience.

Fugitive emissions at coke oven batteries have been drastically reduced by well proven sealing systems for oven doors and other oven closures. Depending on the application, ThyssenKrupp Industrial Solutions offers either FLEXZED® or FLEXIT® oven doors.



Battery front of 6.2m ovens at the GLD coke plant, Detroit, USA

The EnviBAT™ pressure regulation system, former PROven®\*, for the individual control of oven chamber pressure has been developed to a technically matured status within a period of approximately 10 years. It marks a new generation with virtually emission-free battery operation during coking and charging. Since its first application at the Schwelgern coke plant in 2003, almost all batteries installed and commissioned by us have been equipped with this system. The system has also been installed in existing batteries as well.

In total almost 2,000 ovens have been equipped with this system.



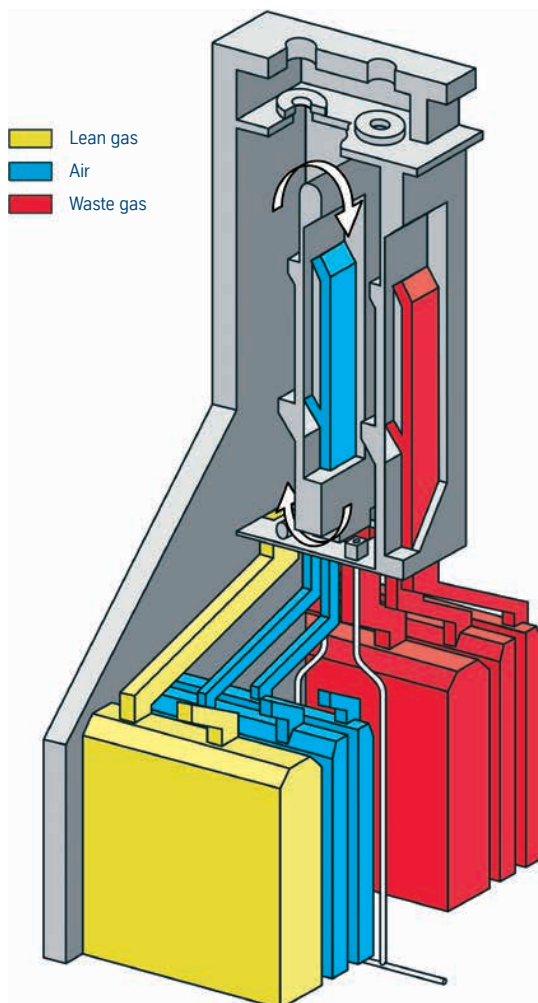
Top view of the battery at Schwelgern, ThyssenKrupp Stahl AG, Germany

\* actually is a trademark of TÜV Nord

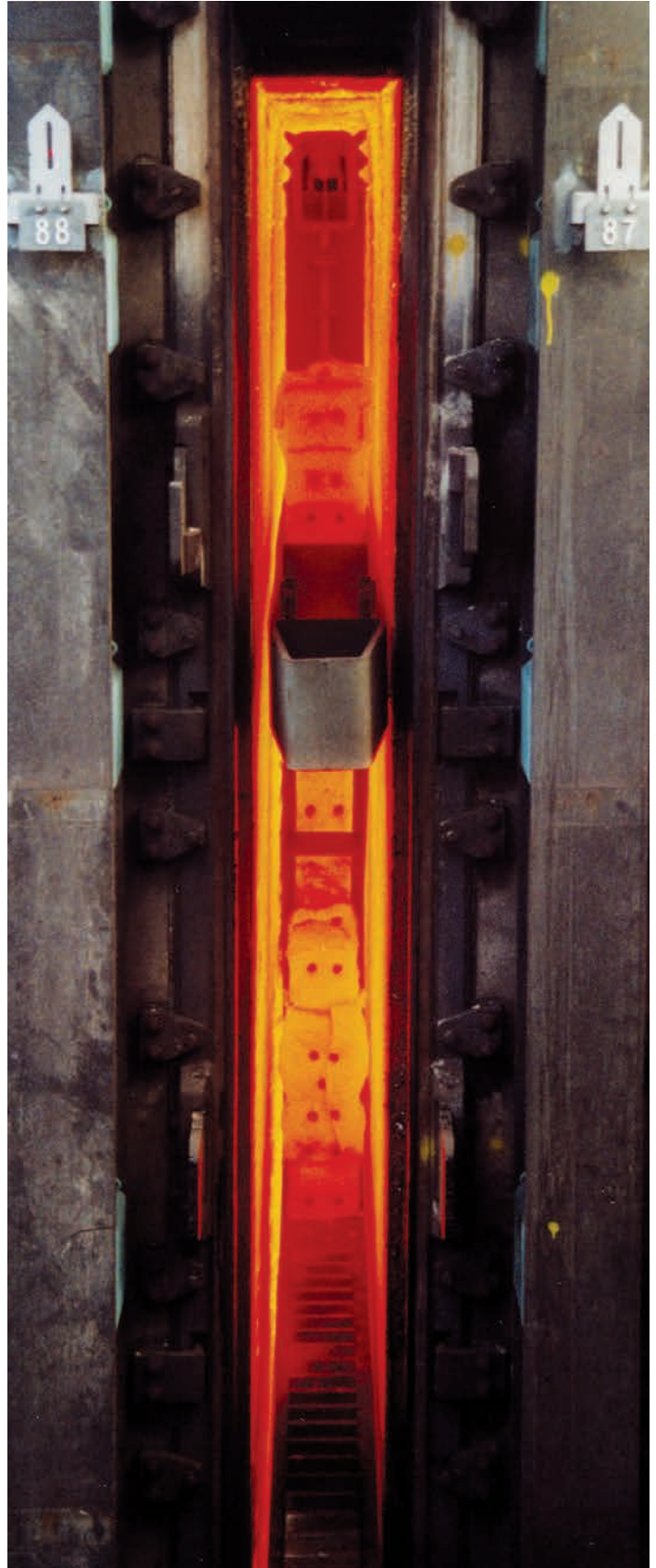
## 4. Heating systems

### Optimised heat distribution – low $\text{NO}_x$

The COMBIFLAME® heating system for low- $\text{NO}_x$  combustion, which was specially designed for large ovens, is equipped with a two or three-stage air supply system. About half the combustion air enters the bottom of the heating zone through the air duct, while the other half enters the heating zone through air ports positioned at higher elevations in the binder wall. The regenerator chambers are divided longitudinally in order to permit individual control of the bottom air and wall air flows. In combination with an internal flue gas recirculation system this results in an optimum vertical temperature distribution over the heating walls while reducing the  $\text{NO}_x$  content of the exhaust gas to a very low level.



COMBIFLAME® heating system with internal waste gas recirculation and staged air supply





## 5. Heating-up burners

### Smooth commissioning with perfect results



Heating-up burners alongside a battery

ThyssenKrupp Industrial Solutions has developed a high-performing, well proven procedure for heating-up batteries by means of external fan burners. These are proven standard industrial units, specially selected and equipped for the task.

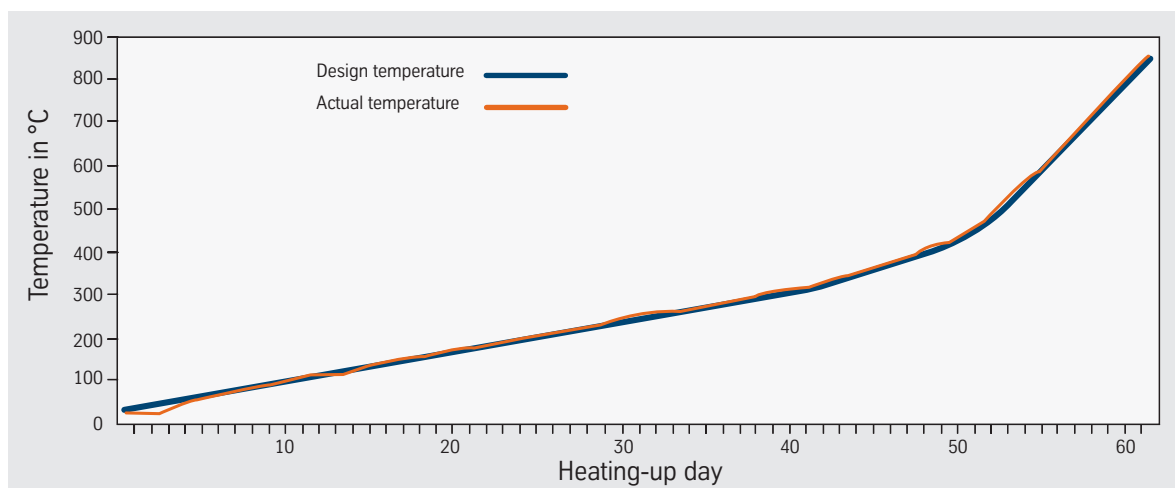
The high overall volume flow of flue gas produced by the fan burners generates a positive pressure in the entire oven block from the very beginning of heat-up, accompanied by optimum heat transfer through-

out the system. Since the hot flue gas is generated outside of the coke oven chamber, local overheating in the area behind the coke oven door is ruled out. Dutch ovens are no longer needed to protect the brickwork. Flame safety is provided by automatic burner management systems, eliminating the manpower formerly required for this purpose.

The increased flow of heating gas from the start allows the heating-up time to be re-

duced by 2–3 weeks. These burners are not only applied for the heating-up of new batteries. They have also been successfully used in refractory hot repairs, where certain areas of the batteries have to be kept at a minimum temperature level.

Batteries installed and commissioned by us since 2000 are being successfully heated up by means of this technology. Our long reference list bears witness to our experience and competence.



Heating-up curve: excellence compliance between set point and actual values

## 6. High stability and gas tightness

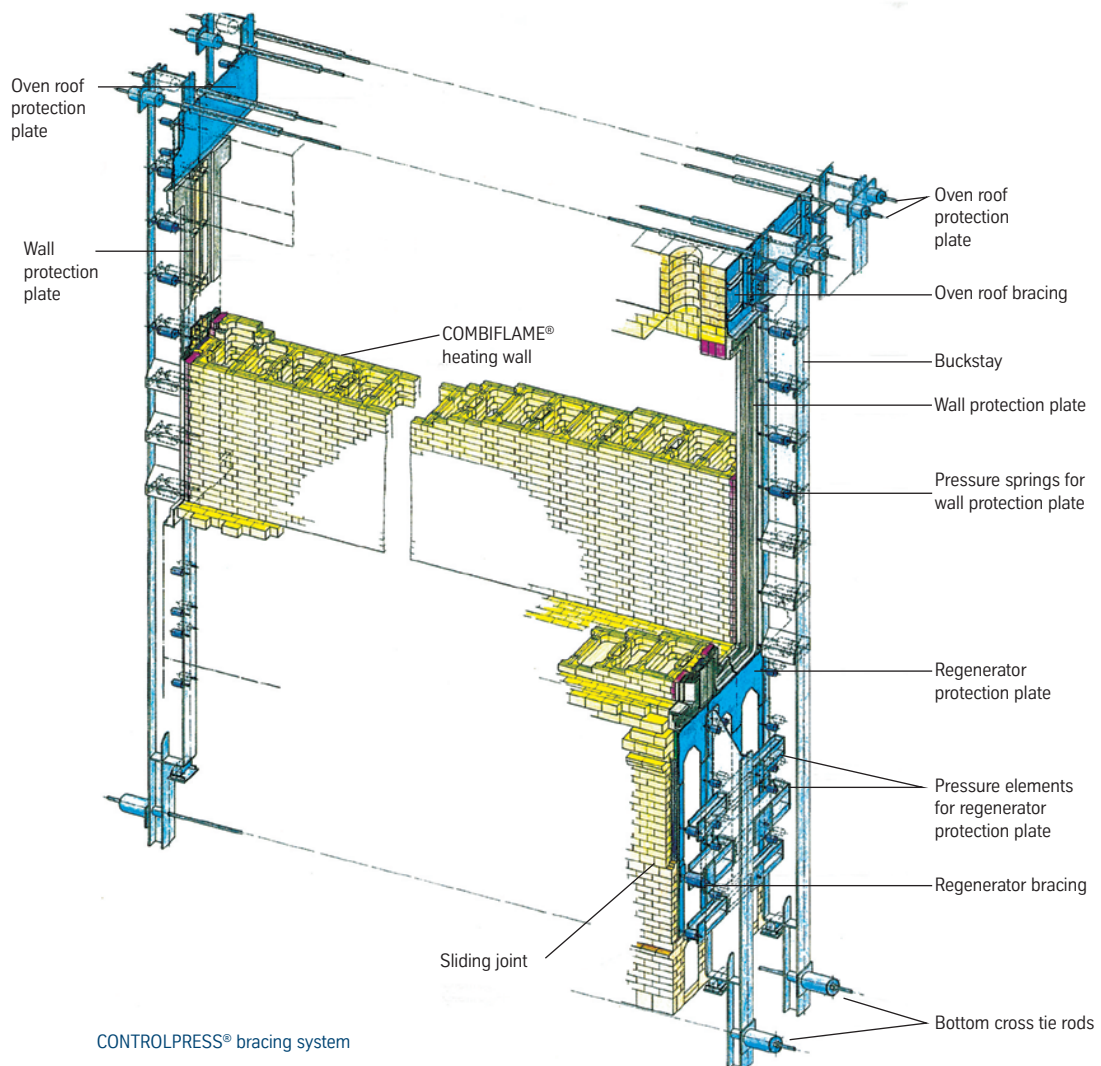
### Prerequisites for safe operation and long service life

The refractory construction, oven bracing, heating equipment, oven door design and every individual detail bear out the extensive experience gained by our engineers over the years. Heating walls are designed and built so as to safely withstand the lateral coking pressure.

The CONTROLPRESS® bracing system provides the required pre-stressing of heating walls, thus protecting the refractory block from uncontrolled forces. This system was developed especially for application in tall coke ovens with large chamber volumes and is today standard cokemaking technology. The high level of wall stability and bracing system reliability in all stages of operation provide for the long service life of our coke ovens.



Heating flue arrangement during bricking-up





## 7. Coke oven doors

### Lasting tightness

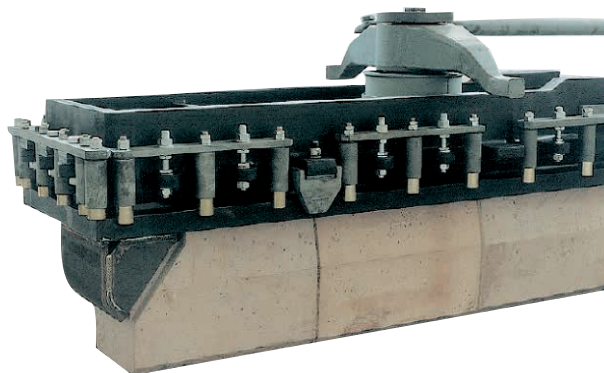
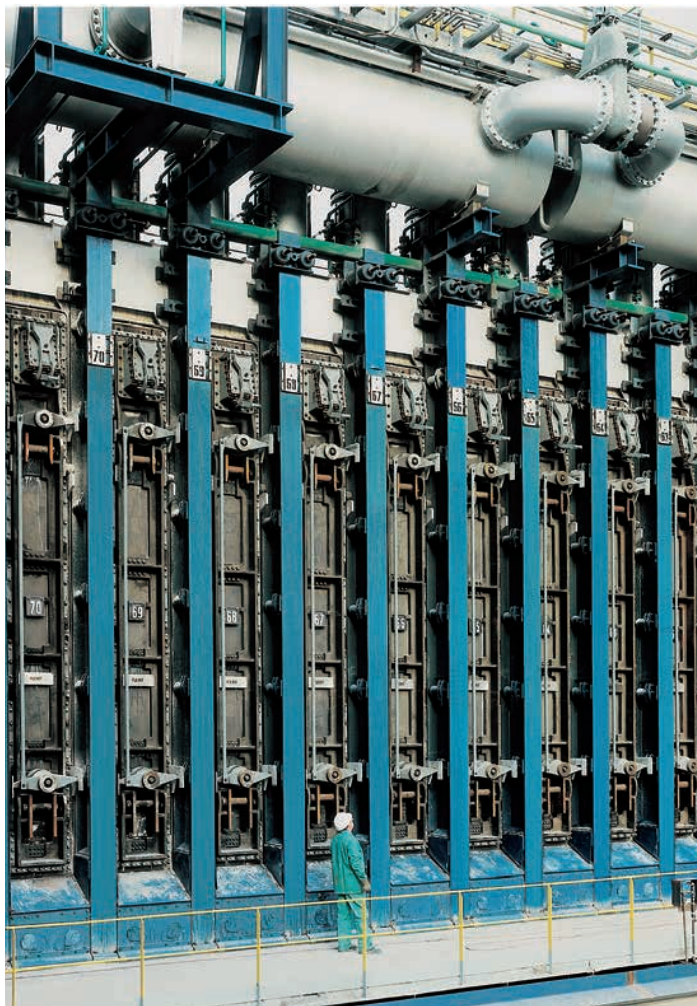
The FLEXIT® and FLEXZED® coke oven doors developed by us ideally suit today's requirements for an environmentally responsible and low-maintenance door system.

The large gas escape channels at the door plug reduce the gas pressure at the door seal – an important prerequisite for the avoidance of door emissions. The seals of these coke oven doors automatically adapt to the door jamb contour, with the required sealing forces being provided by springs acting on the sealing strips. The FLEXIT® coke oven door with its flexible stainless steel membrane and door body made of ductile cast iron is particularly suitable for coke ovens with a large chamber height and chamber width.

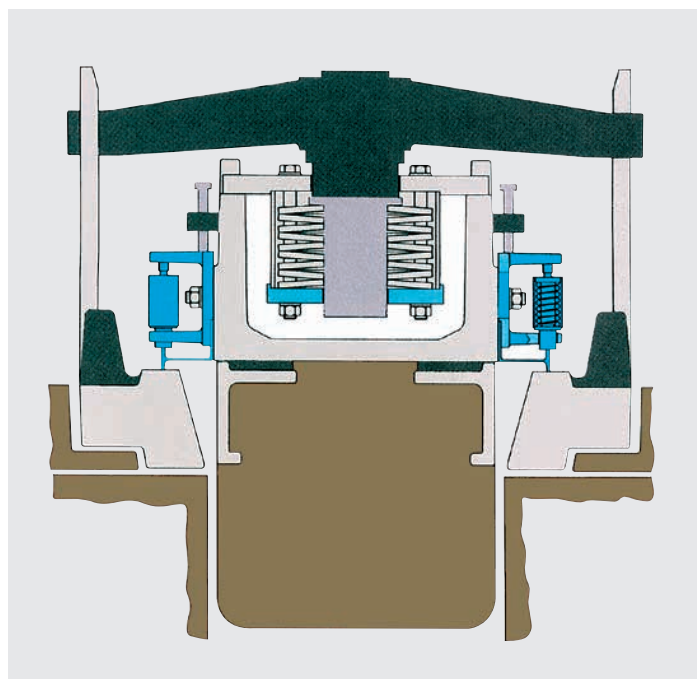
Its high elasticity results in an excellent capacity to compensate for the bending of sealing surfaces, ensuring maximum gas tightness. Hence it comes as no surprise that the tallest and largest coke ovens worldwide are equipped with FLEXIT® coke oven doors.

The standard door for all oven sizes is the FLEXZED® door, which has been installed in thousands of coke ovens worldwide over the decades. With its adjustable Z-sealing strip and its robust cast-iron door body this door has proved extremely reliable in withstanding the severe requirements of coke oven operation. Its special features are a high level of gas tightness, a robust structure and low maintenance requirements.

Installed  
oven doors



Cross section of a coke oven door.



## 8. Environmental protection Innovation at the battery



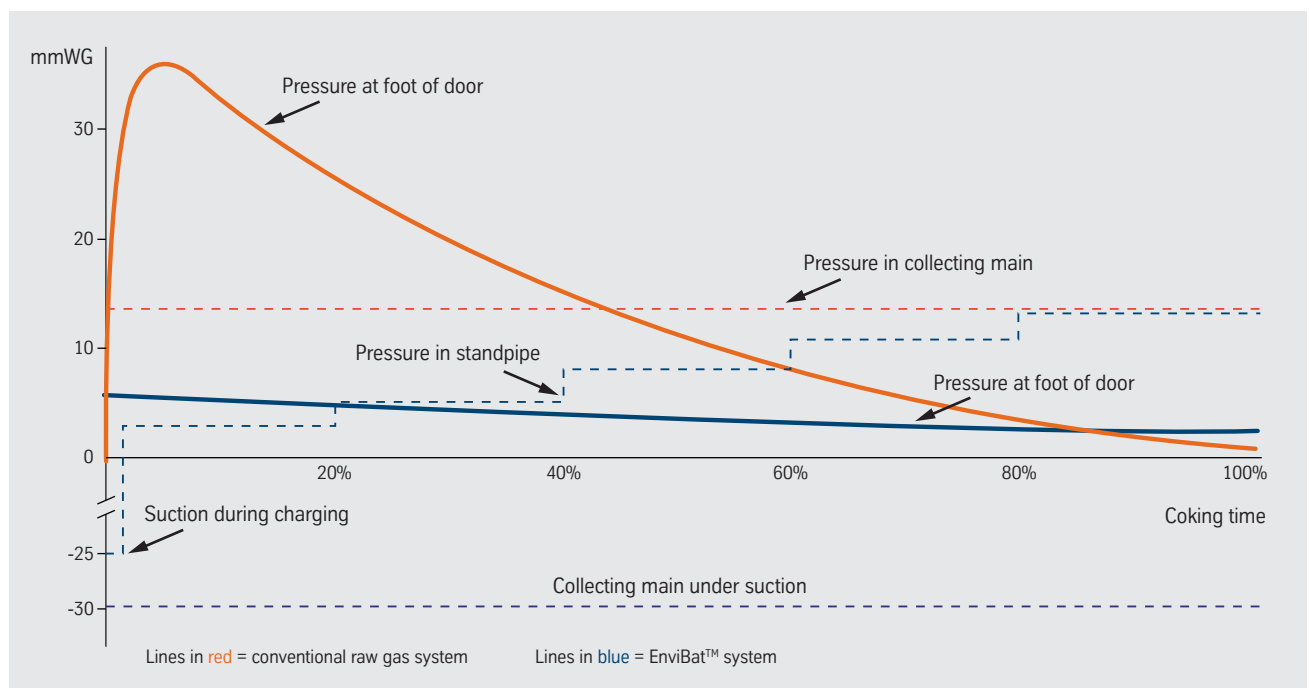
EnviBat™ pressure regulation system under construction

### Single-chamber pressure control

The innovative **EnviBAT™** pressure regulation system, former PROven®, for single-chamber pressure control allows the pressure in each individual oven chamber to be adjusted as a function of the actual raw gas generation rate, thus providing the optimum pressure level for the given coking condition. The gas collecting main itself is operated under suction, and the pneumatically actuated EnviBAT™ valve controls the back-pressure in the chamber. The control system is based on adjustment of the water level inside the EnviBAT™ valve, providing variation of the valve port area through which the raw gas flows.

A low chamber pressure is set at the beginning of the coking time so that the large raw gas quantities generated in this phase are discharged without high gas pressures at the oven doors. Door and oven top emis-

Pressures in the conventional raw gas and PROven® system

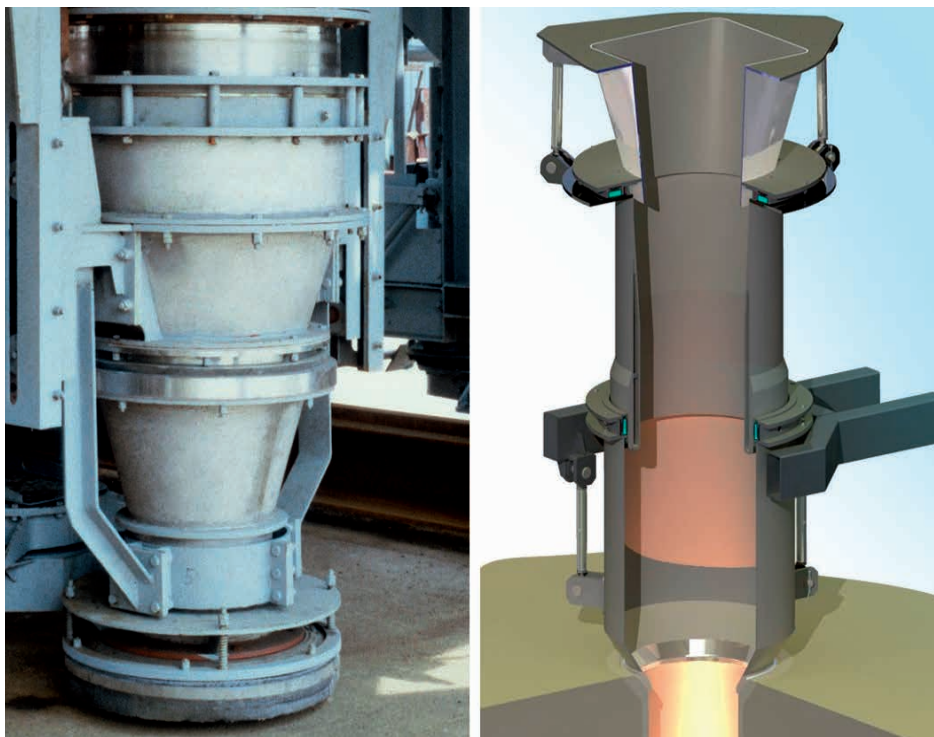




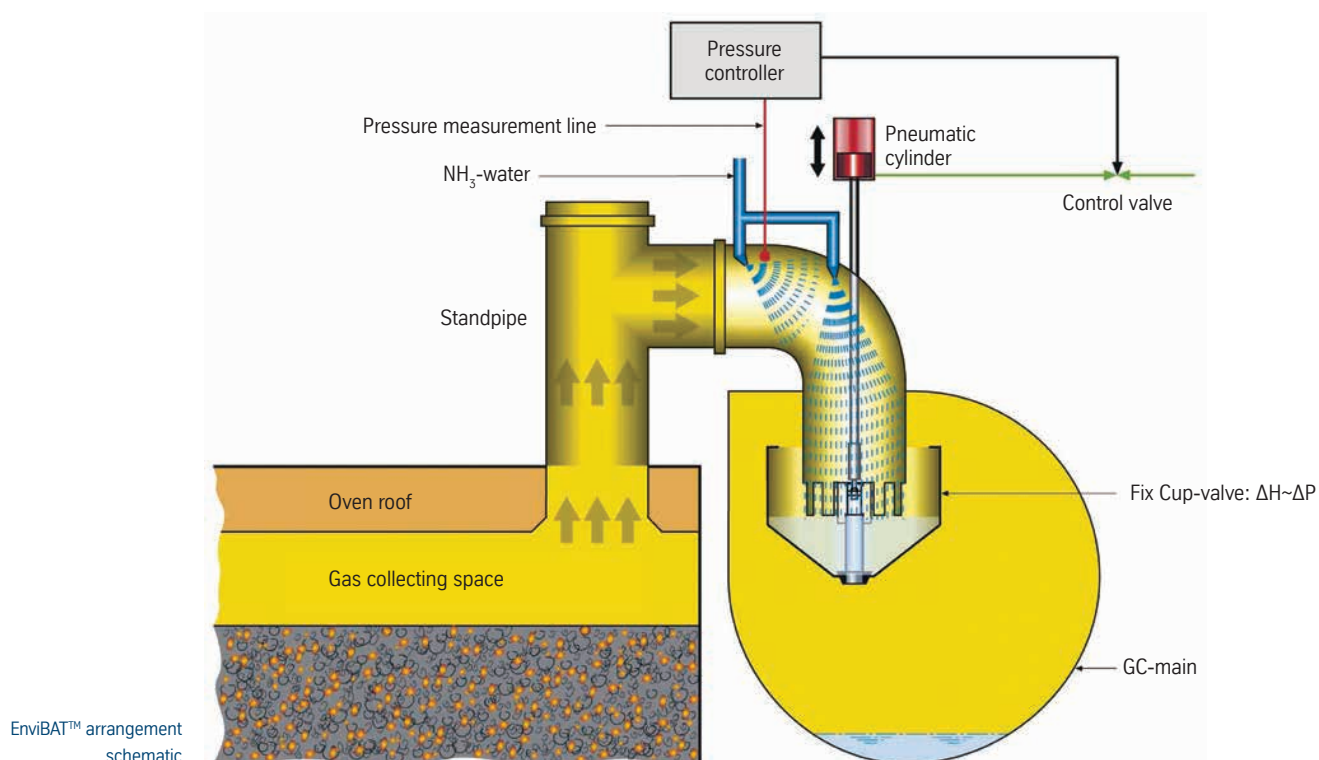
sions are thus prevented almost entirely. As coking proceeds, the chamber pressure is gradually increased in line with the reduction in the gas generation rate inside the oven. When the amount of generated gas declines at the end of the coking process, the pressure in the oven is raised to the point where no air can be drawn in at the doors. This protects the refractory walls from combustion in the end zone of the chambers, thus prolonging the service life of the ovens.

### Reduction of charging-gas emissions

The EnviBAT™ system also ensures that the charging gases are retained within the raw gas system because the standpipes and, consequently, the oven chambers are under suction when charging takes place. Coke oven doors with an efficient sealing system and water-sealed standpipe lids round off the means for preventing battery emissions.



Charging with EnviBat™



## 9. Coke oven machinery

### Comprehensive systems



The increasing dimensions of oven chambers and the demand for high-performance operation have spurred the development of complex oven machinery.

Nowadays, where there may be up to 150 oven cycles per day, so-called "single-spot operation" of the machines which involves no additional travelling is the standard operation for each cycle.

The drivers' cabins are fully air-conditioned and equipped with modern control units, e.g. touch-screen monitors. Comprehensive PLC systems, which are connected to the monitoring and control units of the plant, ensure safe operation.

Travelling and all related operation steps are designed to allow for fully automated operation based on the COKEMASTER® system for battery automation. This system, among other things, controls and adjusts the pushing schedule.

The machines are equipped with state-of-the-art emission control systems that are designed to meet the most stringent environmental regulations.

Moreover, installations, such as automatic cleaners for oven closures, benches, etc., obviate the need for helpers during operation.

Years of development work ensure that coke oven machines provided by ThyssenKrupp Industrial Solutions, whether for conventional or heat-recovery technology, meet the highest standards. We also hold a number of patents to protect all of this know-how.

Approximately 2,000 machines have been supplied to date.

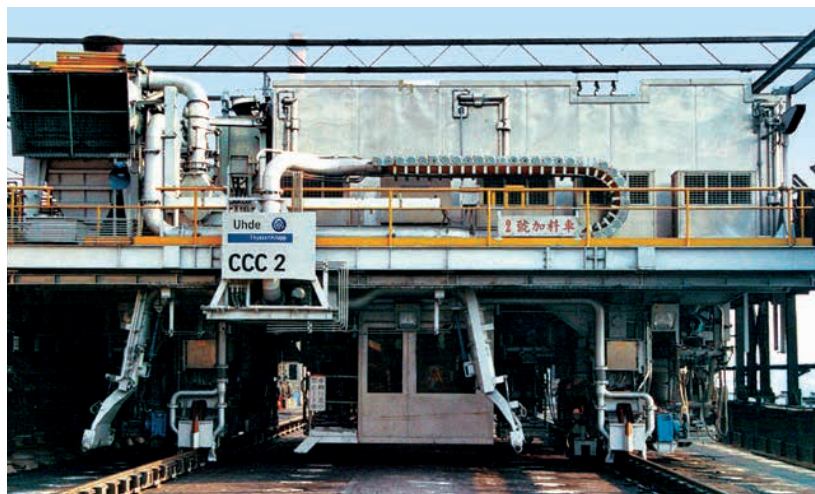


## 10. Charging and pushing

### Safe operation that meets all environmental requirements

#### Coal charging cars

Coal charging cars developed by us are equipped with horizontal screw feeders and gas-tight telescopic pipes. The coal is charged at as high a rate as possible to minimise the charging cycle time and the amount of gas generated. Efficient exhaust systems are provided to ensure gas removal, and thus emission-free charging. These are particularly effective in combination with the **EnviBAT™** pressure regulation system.



Coal charging car

#### Coke pushing machines

The coke pushing machines are equipped with door extractors, mechanical door cleaners, and jamb cleaners. Emissions during door extraction are collected by a retractable hood and fed to the pushing emissions exhaust system.

The levelling operation is also smoke-free due to the tight seal provided by the leveler-bar sleeve.



Single-spot coke pusher machine

# 11. Quenching and door service

## Hot coke transport and oven front maintenance

### Coke quenching cars

The red-hot coke is discharged to the coke quenching car and conveyed to the quenching tower for wet cooling. Single-spot quenching cars by ThyssenKrupp Industrial Solutions provide optimum emission control during the pushing operation. In conjunction with the combined sump and spray quenching system the single-spot quenching car is ideal for producing stabilised blast furnace coke with a moisture content that may be as little as 2%.



Single-spot quench car

### The service machine

ThyssenKrupp Industrial Solutions has developed a service machine which travels along the battery face on the coke and pusher sides. This small machine is ideal for maintenance work on oven doors, the bracing system and refractory structure.

Door Service Car





## 12. Coke transfer and pushing emissions control

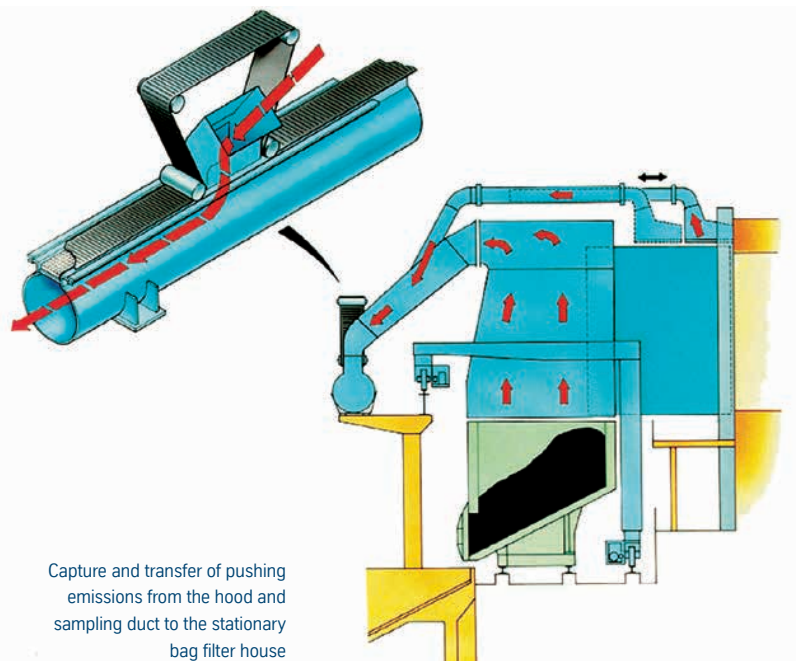
### Advanced combination of operational needs and environmental control



Coke transfer machine with integrated suction hood

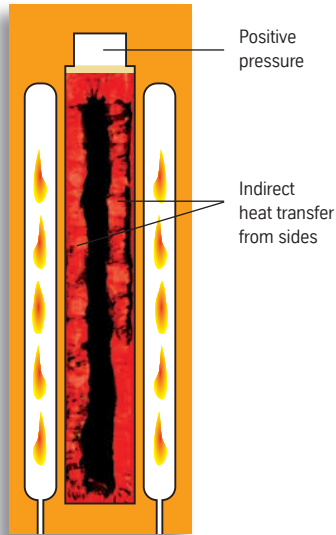
The complete, comprehensive coke transfer and pushing emissions control system features a transfer car with an integrated suction hood. This transfer car is connected via a machine-mounted belt tripper car to the emissions sampling duct, which conducts the dust-loaded air to a stationary bag filter house.

Combined with a single-spot quenching car, the system is so efficient that hardly any emissions can be detected at the hood during pushing. Added to this, the most stringent environmental regulations are also met at the outlet of the bag filter house.

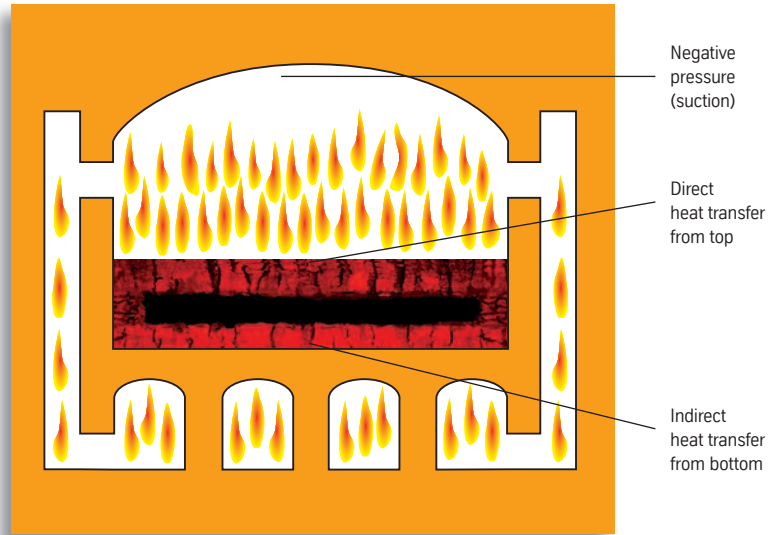


## 13. Heat-recovery cokemaking and related machinery

### Coke, power, environmental protection



Slot-type coke oven



Heat-recovery coke oven

The ThyssenKrupp Industrial Solutions heat-recovery cokemaking technology provides an attractive alternative to conventional coke production in those cases in which power generation is required alongside coke. The technology was widespread in Europe and America prior to the introduction of by-product coke ovens.

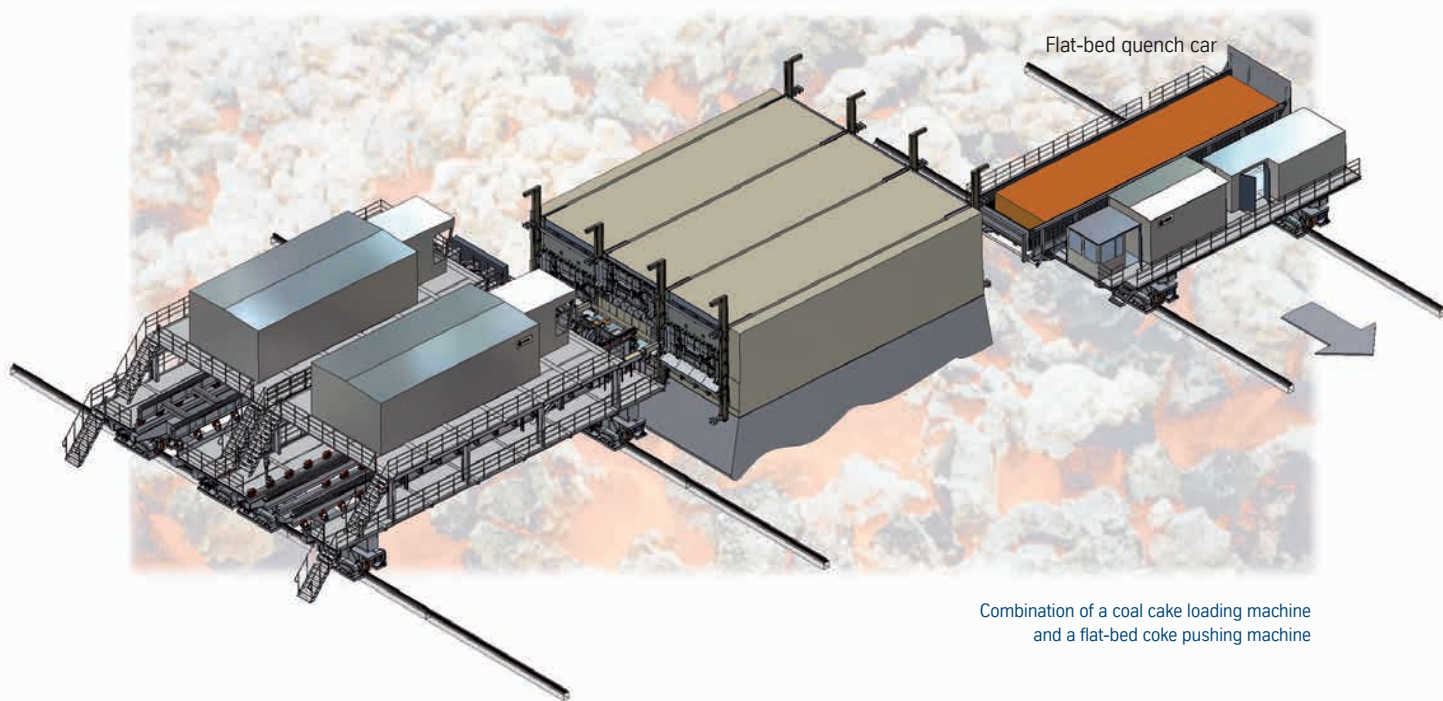
In heat-recovery ovens, the complete gas produced from coal carbonisation is combusted directly inside the coke oven, thus creating the heat needed for carbonisation. In contrast to the slot-type oven, the coal charge for a heat-recovery oven has a flat-bed characteristic with typical dimensions of approx. 1 m in height, 4 m in width and 15 m in length.

As the coal charge is not restrained between heating walls, the lateral coking pressure of the coal blend is far less significant than in horizontal chamber ovens. Coals which develop a higher coking pressure and are thus unsuitable for carbonisation in horizontal chamber ovens can therefore be carbonised safely in heat-recovery ovens.

The crude gas produced from the coal is first partially combusted in the free space above the coal charge. The generated mixture of waste gas and crude gas is led through vertical ducts in the side walls (downcomers) into the heating flue system under the oven sole. Here, the combustion is completed with the staged supply of air so that the coal layer is evenly heated from the top and bottom.







The hot waste gas can be used to generate steam, which can then be used for power generation. Assuming an annual coke production of 1 million tons, approx. 80MW of electric power can be generated, depending on the properties of the coal.

As the ovens are operated under suction, there are no battery emissions during carbonisation and almost no emissions during charging. The waste gas from the ovens is dedusted, desulphurised and then discharged into the atmosphere through suction fans and a stack.

A proven technology is used to charge the ovens with compacted coal. The coal cakes are of a uniform height and do not require levelling. The increased density of this type of coal charge improves the oven throughput,

so fewer ovens are required for a given coke production rate. In addition, fewer charging emissions can be expected.

A flat bed quench car minimises coke pushing emissions by keeping the coke cake in a cohesive mass. This eliminates the need for pollution control systems on the coke side and their associated baghouses. A moveable cover and filter over the coke mass in the car can also be provided. This has been adapted from the flatbed pushing system used successfully for many years at the non-recovery coke plants operated by Illawarra Coke Company Pty. Ltd., Australia.

The heat-recovery cokemaking technology is a virtually emission-free process with comparably low demands on operating crews. It represents a technically and economically lucrative alternative to classical cokemaking.



# 14. Coke oven gas treatment

## Profitable and environmentally responsible

The significance of coke oven gas and its constituents has changed substantially over the past decades. Today, the foremost task of a modern coke oven gas treatment facility is to convert crude gas into an environmentally compatible fuel as economically as possible.

To this effect crude gas is cooled, compressed and freed from constituents that might entail hazards to the environment or plant. Apart from the cleaned coke oven gas, the only by-products produced in modern plants are crude tar, crude benzol, and sulphur. The necessary process steps and equipment are chosen to eliminate gaseous emissions and minimise the level of contaminants in the waste water.

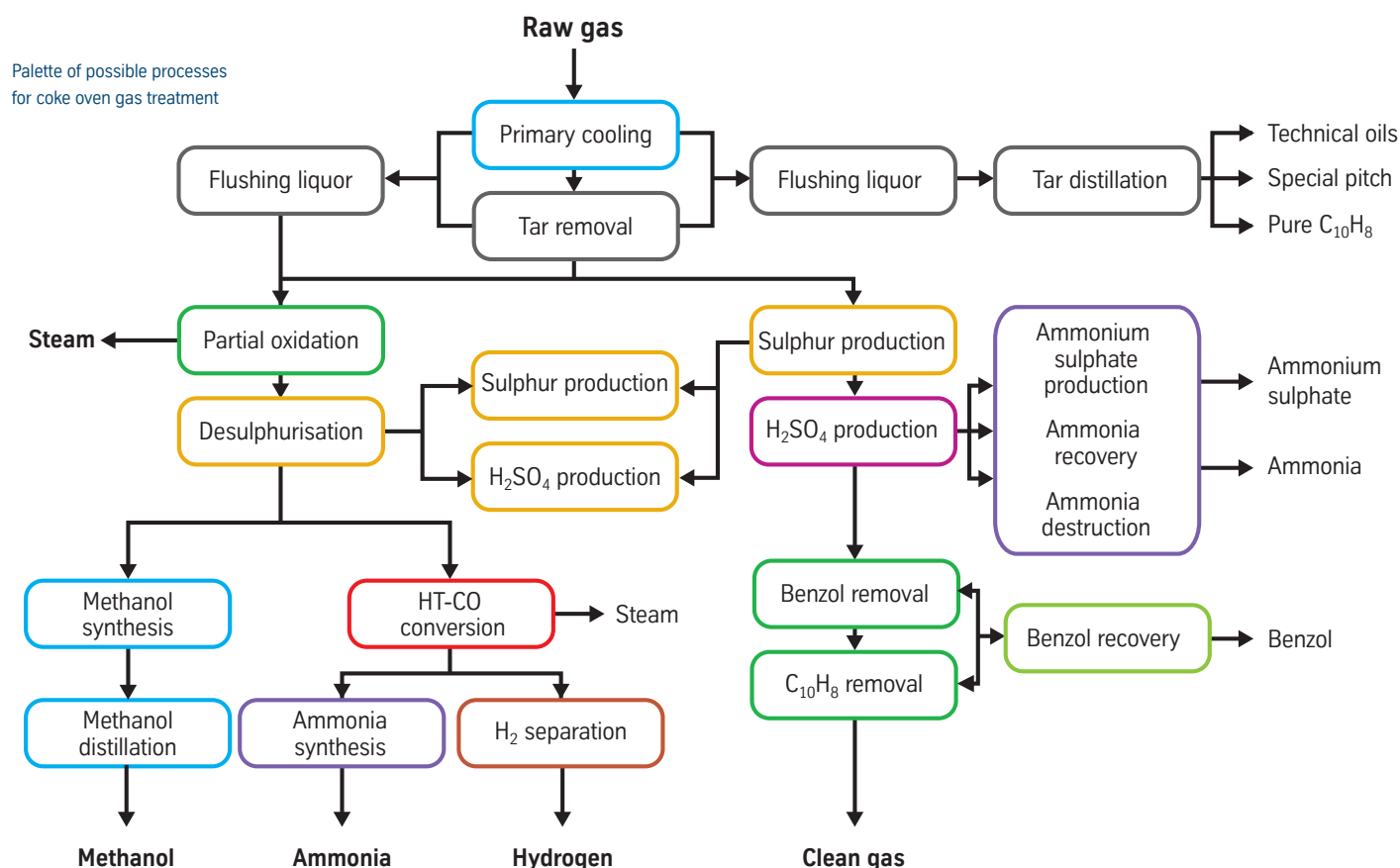
ThyssenKrupp Industrial Solutions offers the full palette of possible process steps for the economical cleaning of coke oven gas and the environmentally responsible processing of by-products and waste water streams.

The array of processes developed in-house and our proven detailed know-how make us the global leader in this field.

A few examples are:

- CYCLASULF® process for the desulphurisation of coke oven gas and removal of ammonia
- VACASULF® process for the desulphurisation of ammonia-lean coke oven gas
- COMBICLAUS®, MONOCLAUS® and COMBACID® processes for the production of elementary sulphur or sulphuric acid in simultaneous combination with ammonia cracking

The many types, combinations and configurations of available by-product recovery processes mean that we can provide a flexible solution to meet specific requirements.





# 15. Condensation and tar separation

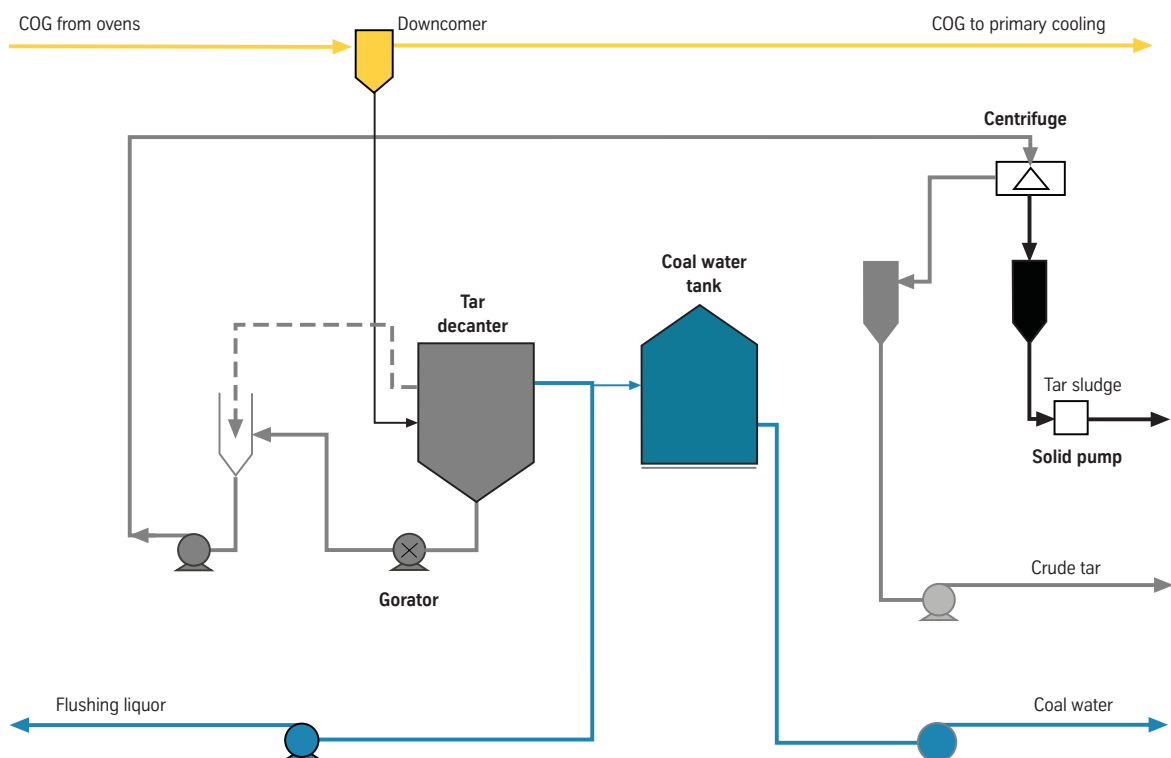
## Sound basis for further process steps

The condensation system, which consists of the primary coolers and electrostatic tar precipitators, frees the coke oven gas from tar and condensate. The exhausters then compress the gas to the pressure needed for the downstream process units. In most gas treatment plants the disposal of tar sludge is carried out manually using equipment that is more or less open to the atmosphere.

In order to reduce environmental pollution and simplify the handling of the tar sludge, a completely closed system has been developed. A centrifuge separates out the tar sludge, which is then pumped back to the feed coal of the batteries by a high-pressure pump.



Primary coolers and electrostatic precipitators at Schwelgern coke plant, Germany



Tar separation with tar sludge removal

## 16. Removal and treating of by-products

### Comprehensive cleaning processes

#### Removal of $\text{H}_2\text{S}$ , $\text{NH}_3$ and BTX

The well-known CYCLASULF® process for the removal of  $\text{H}_2\text{S}$  and  $\text{NH}_3$  has undergone many detailed improvements. By using structured packing, instead of expanded metal packing, for the scrubbers and parts of the desorber, the dimensions of the columns have been reduced significantly. This allows the  $\text{H}_2\text{S}$  and the  $\text{NH}_3$  scrubbers, as well as the deacidifier and the fixed and free ammonia stills, to be combined into single columns. The amount of mechanical equipment and associated investment costs can therefore be reduced drastically. The coke oven gas processed in these purification units can be used as underfiring gas for the coke oven batteries or for applications in the blast furnace.

#### VACASULF® process

The standard process for the desulphurisation of ammonia-lean coke oven gas is the VACASULF® process, which uses potash solution as an absorbent. The absorbed hydrogen sulphide is recovered as sour gas through regeneration under partial vacuum. The partial vacuum in the  $\text{H}_2\text{S}$  stripper allows the use of very low-temperature heating media. The heat required for regeneration of the potash solution is supplied indirectly. The heat requirement can be provided either by sensible heat from the hot water generated at the top of the primary cooler, by sensible heat from the flushing liquor before it enters the collecting main of the coke oven battery or by latent heat using low-pressure steam. Most of the equipment is fabricated from carbon steel, with a negligible portion of stainless steel.

VACASULF® coke plant,  
Fürstenhausen, Germany



#### Sulphur recovery

The sour gas vapours released from the  $\text{H}_2\text{S}$  and  $\text{NH}_3$  desorption system are further treated in the sulphur recovery unit. Many coke plants have adopted the CLAUSS process with simultaneous  $\text{NH}_3$  destruction to produce liquid sulphur. In order to reduce investment and operating costs, a modified MONOCLAUS®-process has been developed by ThyssenKrupp Industrial Solutions.

Contrary to the usual CLAUS-process the kiln is positioned horizontally, the process gas cooler and sulphur condenser are combined in a common unit and only one CLAUS reactor is used for the catalytic conversion. In this way the costs for piping, steelwork and instrumentation can be reduced by about 30%. The tail gas is recycled to the raw coke oven gas so that no emissions occur.

Depending on specific requirements other  $\text{H}_2\text{S}$  processing technologies can be provided, such as conversion to sulphuric acid for use in combination with ammonium sulphate production.





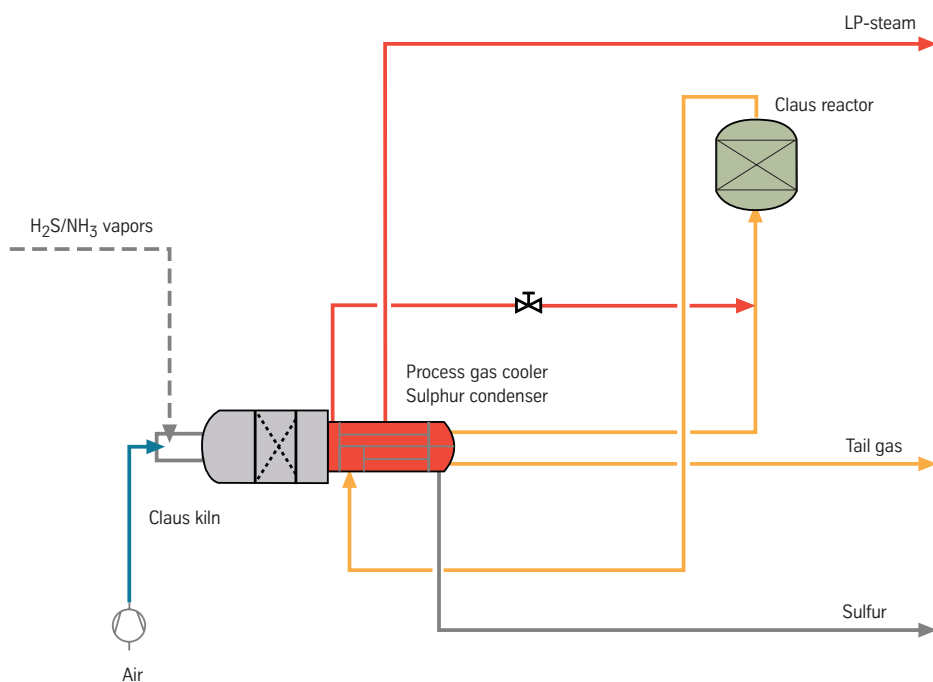
Gas treatment unit at  
Schwelgern coke plant, Germany

### BTX recovery

BTX and/or naphthalene components can be removed from the coke oven gas using two main types of wash oil. The normal degradation of petroleum-based wash oil makes it more suited to once-through operation, whereas tar-based wash oil can be successfully regenerated and recirculated to the BTX removal process. The recovered BTX fraction has a typical boiling range of 95% at 180°C.

### Biological treatment

The waste water effluent from the  $\text{H}_2\text{S}/\text{NH}_3$  regeneration unit comprises the water present as the coal moisture, the water released during coking and the condensed direct stripping steam. The total concentration of  $\text{NH}_3$  in the waste water is less than 100 mg/l. Biological treatment can be used to condition the waste water before it is discharged from the plant if this is required by local regulations.



MONOCLAUS® process



## 17. Tar refining

### Huge variety of products

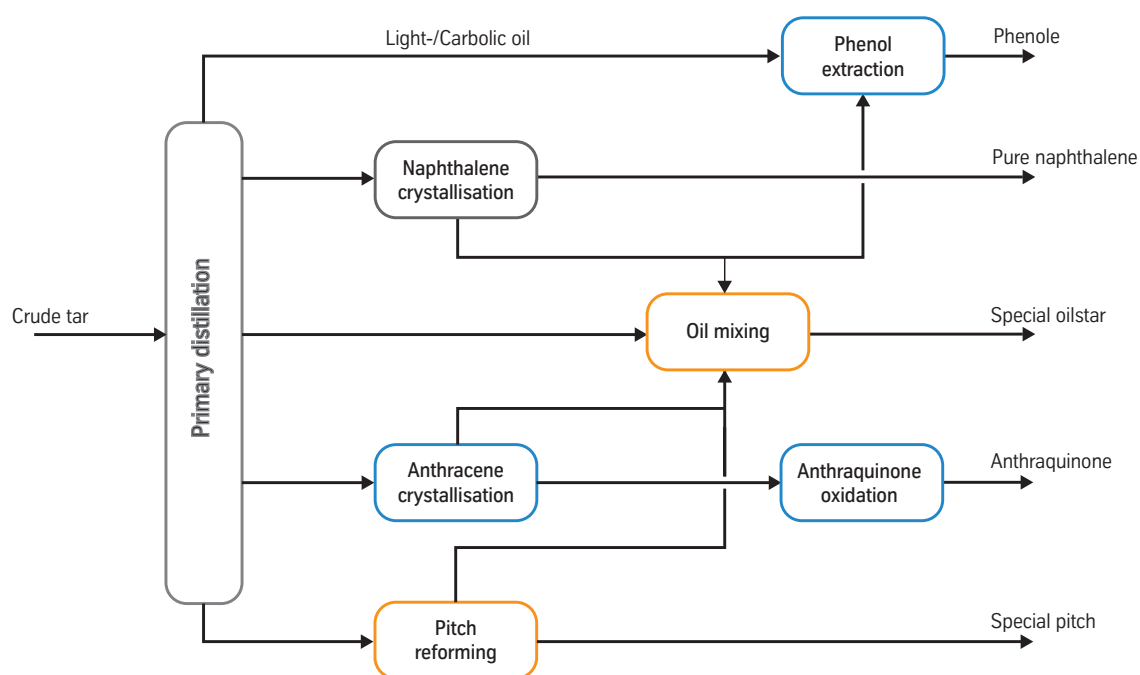


Typical tar distillation

The feedstock of the tar refining plant is typically the crude tar recovered in the coke oven by-product plant. A wide range of products can be separated from the crude tar.

The state of the art for primary distillation consists of two alternative systems. The first is complete vacuum distillation, the second a combination of atmospheric and vacuum distillation.

In order to reduce operational problems, solids are separated from the crude tar using a centrifuge. This is followed by neutralisation to reduce the corrosion hazard. The separation of tar fractions with individual boiling ranges uses a system of distillation columns with direct heaters and an efficient heat recovery system. The main products of the primary distillation are the light oil, naphthalene oil, wash oil and anthracene oil-fractions and a normal pitch as the residue.



Tar distillation process



## 18. Alternative use of coke oven gas

### Hidden treasures



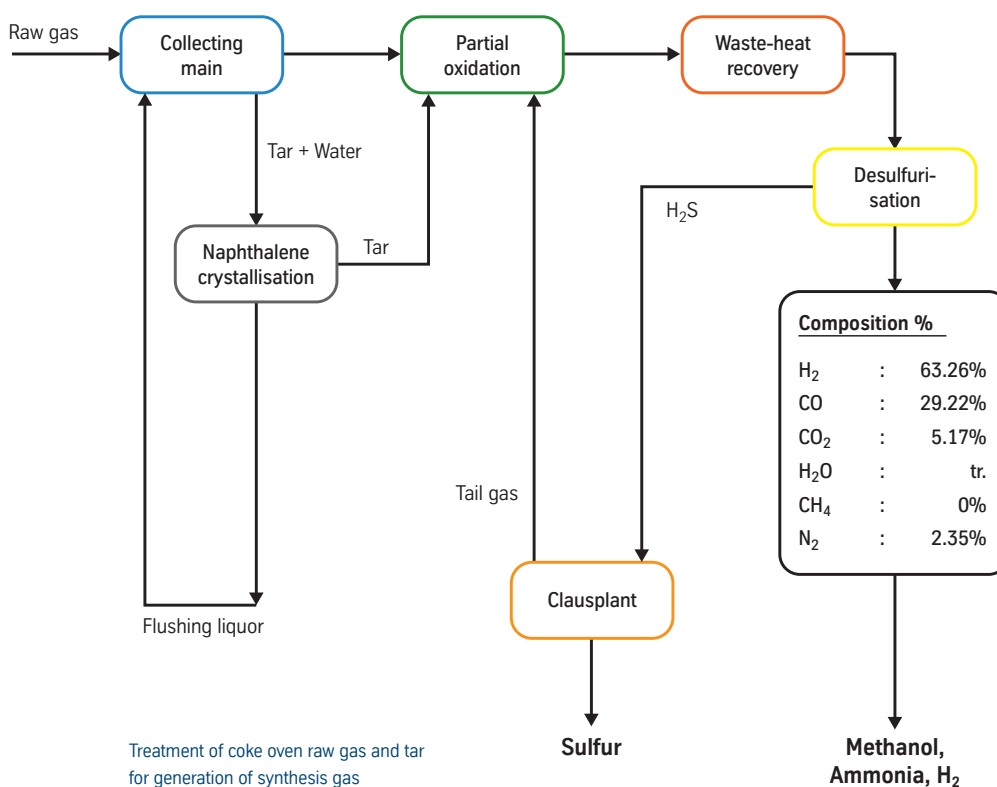
Methanol plant

With the emphasis on increasing coke production and less on by-products, the use of coke oven gas for alternative purposes is becoming more and more attractive. The high hydrogen-content of coke oven gas makes it suitable for direct use as a synthesis gas (see table below).

Proven technologies can be applied, such as methanol or ammonia synthesis or  $H_2$  separation. In order to meet the requirements of the synthesis processes, ThyssenKrupp Industrial Solutions has developed and diversified the standard gas treatment process.

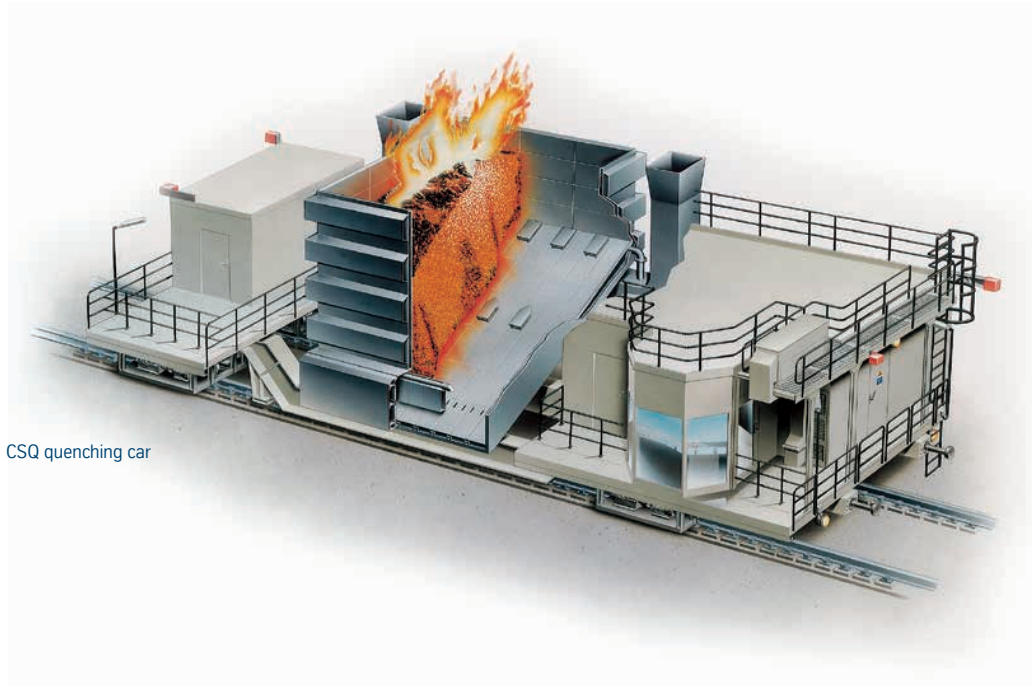
Vol.-%	Coke oven gas	Direct reduction gas	Methanol-synthesis gas	$NH_3$ -synthesis gas	$H_2$ -gas
$H_2$	63	66	69	75	> 99.5
CO	8	27	22		< 0.1
$CO_2$	3	3	8	-	-
$CH_4$	21	-	0.5	0.1	-
$N_2$	5	3.6	0.5	25	< 0.4
$H_2S$	< 0.02	< 0.02	-	-	-

Gas composition



## 19. Coke cooling

### A wet quenching trendsetter



CSQ quenching car

CSQ quenching tower,  
Schwelgern plant, Germany

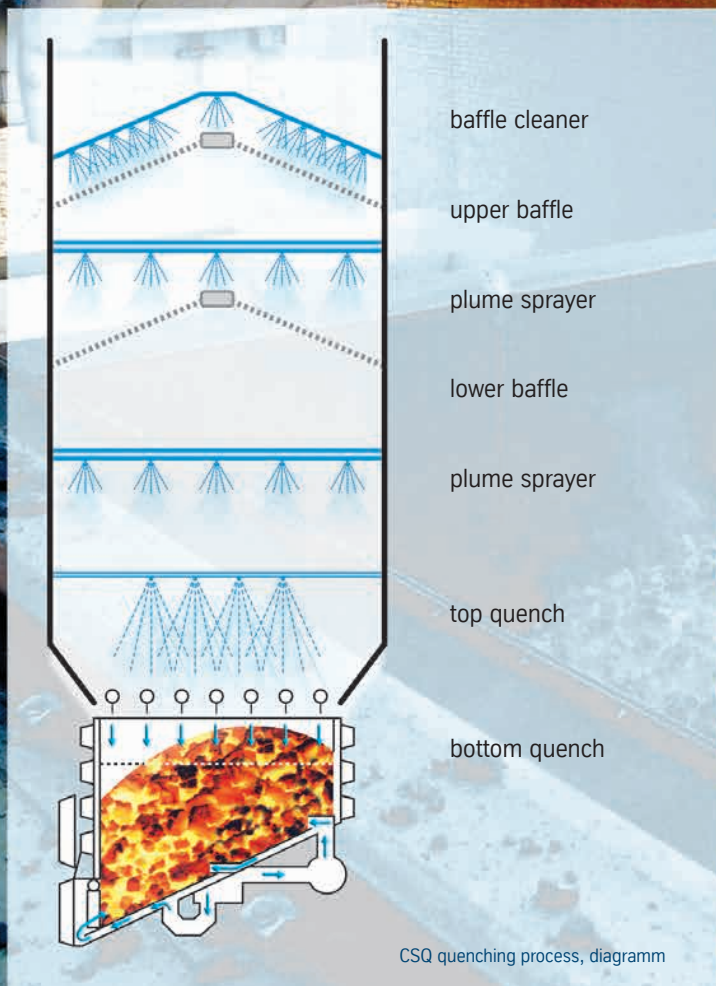


#### Coke Stabilisation Quenching (CSQ)

Two main components characterise the CSQ wet quenching process. One is the quenching car prepared for a combined feed of quench water from the top and bottom of the hot coke. The other is the quench tower itself, prepared for this type of quenching but additionally equipped with installations for thorough removal of particulate emissions as generated during the quenching process. The quenching procedure features very high water feed rate and a very short quenching time. The specially developed single-spot quenching car has a coke bed depth of approx. 4 m. The combined top and bottom quenching procedure develops flash steam which agitates the coke intensively, ensuring the entire coke charge is stabilised and evenly moistened.

Because of its uniform grain size, high stability and reduced moisture content of only approx. 2%, coke quenched by the CSQ process is particularly suitable for tall blast furnaces run on high pulverized coal or high oil injection rates per tonne of hot metal.





### CSQ emission control

The quenching process with a combined top and bottom supply of water works in connection with the reduction of particulate emissions. The dust-loaded steam generated during the quenching passes through several stages inside the quench tower.

Two baffle systems are installed, both serving as impact separators for the particulates by redirecting the flow of the plume. The lower one is made of stainless steel material to withstand higher temperatures while the second system is equipped with polypropylene plates which are arranged more closely to each other than the stainless steel units, thus allowing even the finest particulates to be separated out. The top baffle arrangement is cleaned after each quenching cycle by a water spray. This scrubbing uses clean service water

only – not quenching water– which at the same time compensates for part of the loss due to evaporation.

Additional dust removal is provided by two plume spraying devices, one positioned directly above the top quenching level, the second one above the lower baffle system. This dust removal process is characterised by partial condensation of the plume in that the intensive stream of droplets emitted by the scrubbers mixes with the rising steam, so forming bigger drops. A substantial part of the quenching plume is thus condensed at an early stage and the particles are absorbed by the water droplets. The upper plume sprayer also serves for cleaning of the lower baffle system. The particulate emissions associated with this technology are as low as emissions generated by Coke Dry Quenching (CDQ).

## 20. Coke plant automation

### Flexible solutions with COKEMASTER®

#### The challenge

To be able to operate a coke oven plant at optimum efficiency, it has to be equipped with state-of-the-art automation technology. The aim of automating the process sequences is to facilitate the long-term adjustments required to meet environmental protection requirements.

#### The engineering

ThyssenKrupp Industrial Solutions has been successfully engaged in the automation of coke-oven plants since 1980. The automation systems supplied by us are tailored to the customer's specific requirements in each case. The modular design of the automation systems facilitates this.

#### The results

To meet the challenge, the following system structure has been developed under the umbrella of the **COKEMASTER®** automation architecture:

The **AutoTherm™** measuring system uses its six infrared sensor heads to measure the surface temperatures of the two heating walls at three different levels during each coke pushing operation. In other words, the heating walls are thermally scanned, allowing an exact

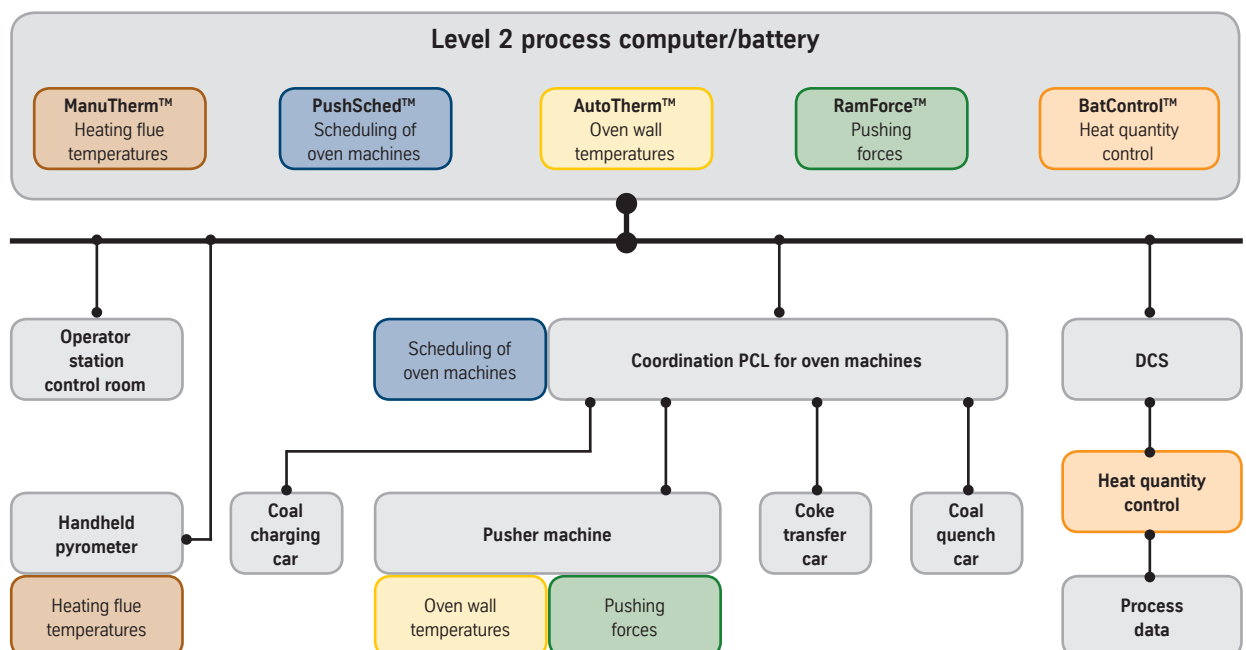
overview of the temperature distribution in each heating wall. The aim is to keep the temperature distribution in the heating walls as uniform as possible and to detect any changes.

The **ManuTherm™** system is an infrared pyrometer with integral data memory for taking manual measurements at the heating flues. Its main job is to measure heating flue temperatures when no AutoTherm™ measurements are available, for instance when no coke pushing is taking place for operational reasons. Also, detailed spot measurements can be taken where heating problems have been detected by AutoTherm™. These temperature measurements can be fed into the computer system and used for further calculations and evaluations.

The **BatControl™** system calculates the amount of heat required for the battery, taking into account all relevant operating parameters such as coal quality, coal moisture, coke pushing schedule, etc. The heating situation is controlled automatically and the heat input is corrected immediately upon detecting a fault, such as a delay in production or a change in temperature.

The **PushSched™** system is an automatic pushing and charging schedule calculation program designed to assist operating crews. The production plan is recalculated

Automation system  
for battery operation

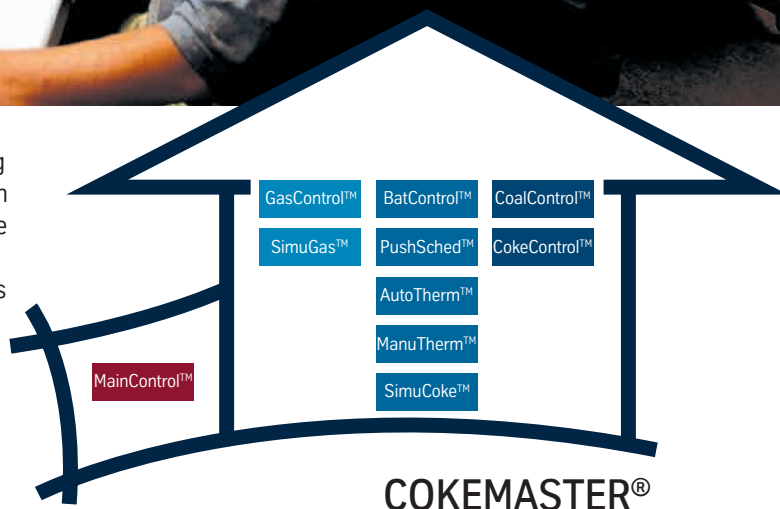




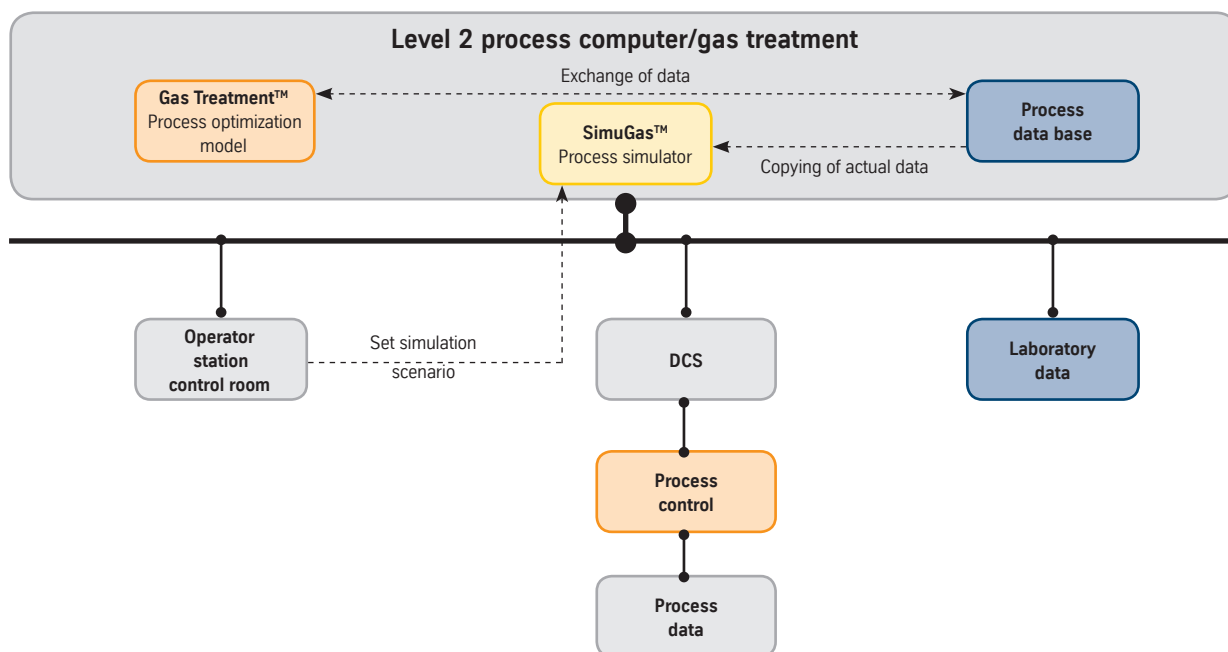


continuously after every coke pushing operation, taking into account special operating conditions such as "oven with extended coking time" or "oven out of service". The resulting production schedule is transmitted to the machines. Confirmations received from the oven machines are forwarded to the BatControl™ system so that the heating can be corrected automatically.

The **GasControl™** system is a process model for gas treatment plants. The process model consists of the CHEMCAD commercial simulator for chemical plants plus extension modules by ThyssenKrupp Industrial Solutions for individual coke-oven-specific machinery and equipment. The GasControl™ process model uses chemical and thermodynamic mass equilibria and streams to rate each individual gas treatment unit and determines the input and output streams, interlinking them in accordance with the plant flowsheet. The model is supplied with the relevant on-line process variables from the plant instrumentation in real-time mode (via the process control system) and the process model is calculated dynamically. By varying the control param-



eters (e.g. steam rate, water rate, etc.) in this virtual plant it is possible to optimise the operating results. The control parameters that deliver the best operating results are retransmitted to the plant instrumentation to set the local controllers in the "real" plant. All important data can be displayed on screens, reports and trend charts. This model is not only a powerful tool for plant optimisation and automation – it can also be used in an off-line simulation mode as a training tool for operators.



Automation system  
for gas treatment  
plant operation

## 21. Technology services

### Successful plant operation over the entire life cycle



Coke oven door survey



Broad inspection services and trouble shooting

Would you like your plant to be operating optimally and successfully throughout its entire lifetime?

Market conditions, feedstock, product quality, environment, plant lifetime, safety – things are becoming increasingly dynamic and challenging these days.

Coke Plant Technology Services team of ThyssenKrupp Industrial Solutions can help you to master these challenges on a competent, reliable and customised basis.

Our service portfolio comprises:

#### Performance Improvement and Revamp

Coke oven, gas treatment plants and service machines all require modernisation and continuous optimisation to ensure the most reliable and efficient plant operation.

Examples:

- Installation of gas-tight coke oven doors
- Revamp of the gas collection system including **Envibat™** pressure regulation implementation
- Modernisation of the bracing system
- Revamp of absorption/desorption columns with structured packing
- Implementation of process automation

#### Inspection, Training, Troubleshooting

Our service team analyses customers' problems on an interdisciplinary basis and provides them with specific solutions.

Examples:

- Studies on extending the useful plant life
- Preventive or incident-based inspections (bracing system, refractory, heating system, machines).
- Process-related consulting (coke oven operation, gas treatment, heating system, machine coordination)
- Training for operating teams and maintenance personnel (new employees or refreshment)
- Helpline/Teleservice/Troubleshooting



### Hot repair

Hot repairs are the best option when the battery structure has deteriorated to such an extent that preventative maintenance will not meet expectations in terms of battery lifetime and economic considerations.

#### Examples:

- End flue repair up to through-wall repair
- Oven roof repair
- Provision of sophisticated know-how (logistics, design of interface between new and old brickwork, precise investigation of conditions for construction/commissioning)

### Components and spare parts

With the technical experience and market knowledge of ThyssenKrupp Industrial Solutions specific components/spares requirements of our customers can be fulfilled.

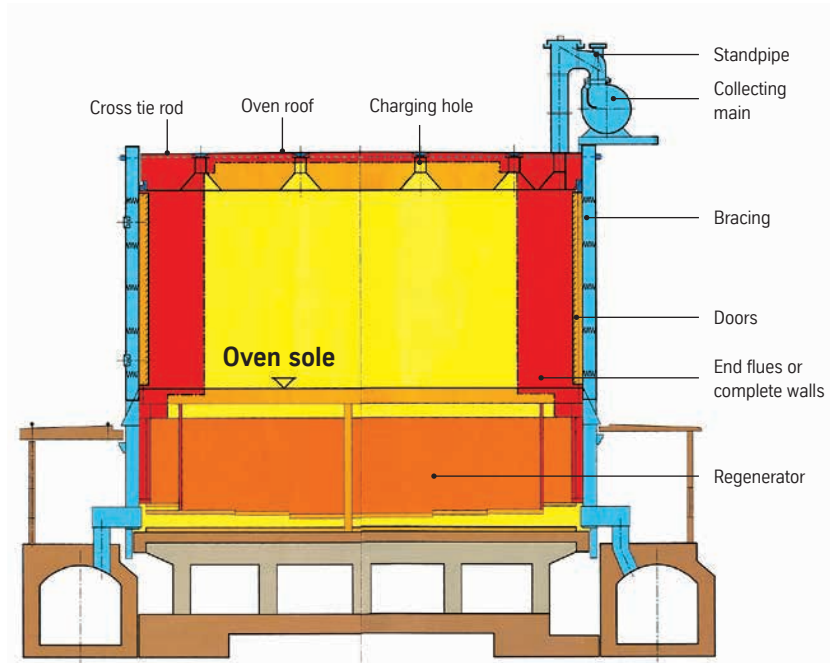
#### Examples:

- Procurement of both proprietary and standard equipment based on our comprehensive archive and database
- Engineering and procurement of alternative spare parts for obsolescent equipment
- Procurement of process-specific consumables
- Utilisation of our excellent supply contacts

Thanks to many years of experience backed up by corresponding references, we can provide in whatever kind of technology service you need.

Some of the required tasks may be highly complex and in need of an integrated approach. Thus, where appropriate, our Coke Plant Technology Services collaborates closely with all relevant in-house departments and subsidiaries in the global ThyssenKrupp Industrial Solutions service network.

The team for Coke Plant Technology Services can be contacted quickly and easily by email ([Cokeplant-support.uhde@thyssenkrupp.com](mailto:Cokeplant-support.uhde@thyssenkrupp.com)), fax or phone.



Typical battery revamp measures



Helpline/teleservice



Oven roof repair



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