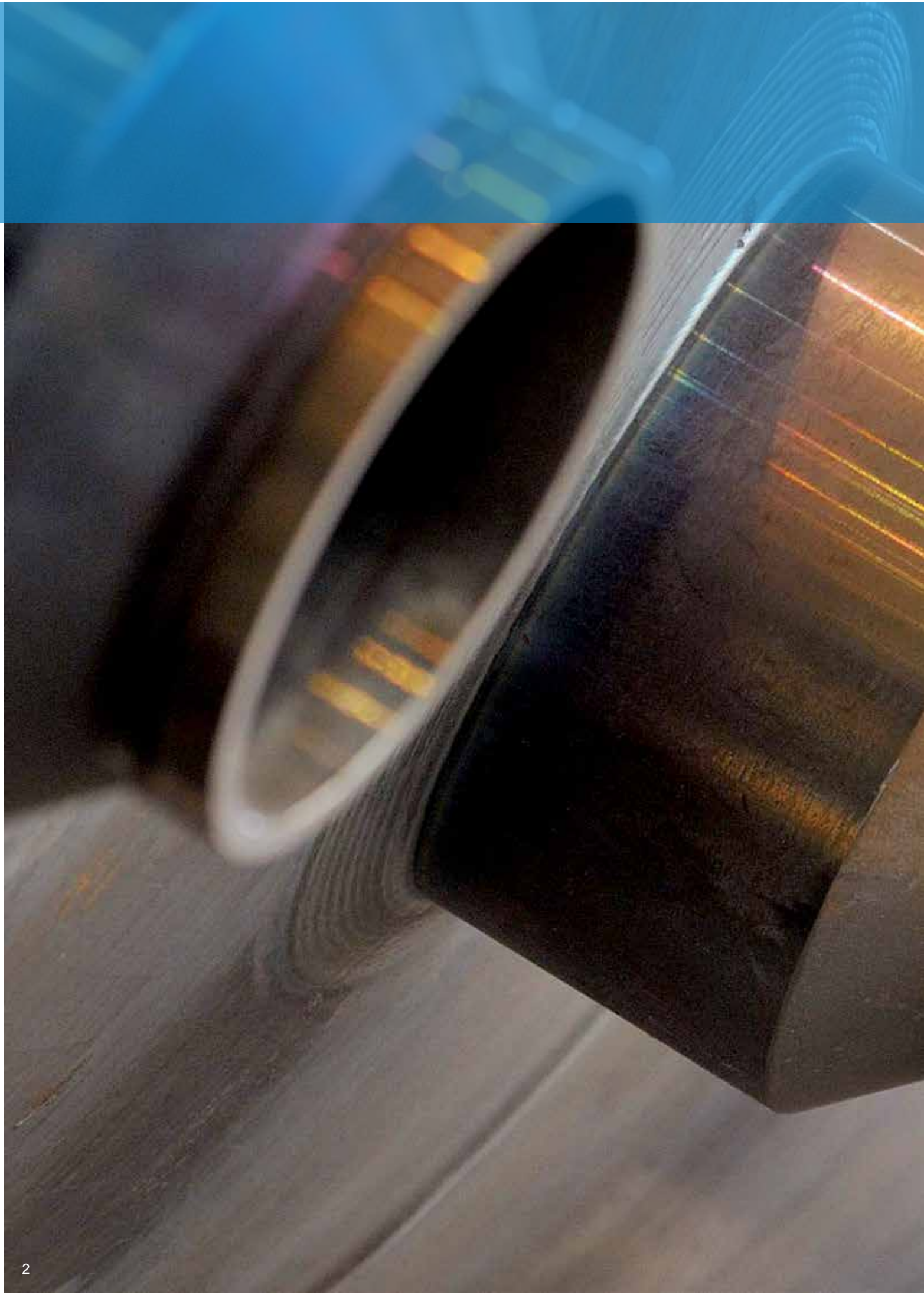
BORSIG

LEADING TECHNOLOGY FOR INNOVATIVE SOLUTIONS

KNM



Content

1

BORSIG Group

Leading Technology for Innovative Solutions

The **BORSIG Group**, member of the KNM Group Berhad (Kuala Lumpur/Malaysia), offers customized process solutions for applications in the chemical and petrochemical, oil and gas industries as well as the power plant sector.

The successful product range comprise pressure vessels, heat exchangers (e.g. waste heat recovery systems and transfer line exchangers), compressors (reciprocating and centrifugal compressors), membrane technology (e.g emission control, product recovery and gas conditioning units) as well as a comprehensive power plant and industrial services.

Our experience is based on more than 175 years of company history. The resulting competence enables us to successfully master all economic, technical and social challenges both today and in the future.

All BORSIG products are synonymous with top quality, reliability, optimum technical implementation and smooth order processing.

Innovative solutions, state-of-the-art technology, perfectly trained specialists and comprehensive know-how are the basis for our position as a single source supplier of leading technology.

The BORSIG Group – your competent partner for the future.

1.1 Manufacturing

BORSIG, one of the oldest and longest standing companies in Germany, is able to look back on more than 175 years of experience in the development and production of customized components for industrial plants. In this, we represent quality, reliability and innovation power from Germany. Our highly qualified engineers and technicians aspire to developing, producing, and installing only the best plants and machines on the final site. As such, our products are efficient even under the harshest conditions and represent an investment in the future. At our production sites, our employees work at the highest level and guarantee a consistently high quality standard by means of the latest technologies, innovative production processes and workshops and their personal dedication. Each production site has its own outstanding qualities.

BORSIG Process Heat Exchanger GmbH in Berlin owns more than 16,700 m² of indoor workshop facilities and is equipped with a 250 t crane capacity. High-tech welding technology is our core competence, such as the laser controlled welding seam guidance system for submerged narrow-gap welding, the use of robot welding systems for the GMAW welding process in the high pressure vessel manufacture, GMAW narrow gap robot systems with integrated 3D cutter systems plasma and autogenous, TIG hot wire welding, RES and SAW strip weld cladding, the automatic tube to tubesheet welding incl. inbore welding of up to 500 mm as well as qualified machining of all steel and nickel-based alloys.
The company has a direct water connection since 2008, the Borsig-Harbor, so that pressure vessels and heat exchangers of every overall size can be transported easily on the water way.

BORSIG ZM Compression GmbH´s fabrication shop in Meerane/Saxony has more than 10,000 m² area available, equipped with up to 100 t of crane capacities. The heart of the fabrication shop are two CNC boring and drilling machines with a maximum travel path of 14 m and a piece weight of up to 40 t. The extensive CNC machinery is linked to a modern programming system for the simulation of complex machining tasks followed by error-free processing. Thus, BORSIG ZM is capable to machine cylinders, impellers and other components for our compressors in-house. The machining of forged components, cast steel, modular graphite cast-iron and stainless steel is a daily routine for us.
We have our own test facility with a surface of 1,700 m², 8 work stations and a power input of up to 5 MW for function and performance tests of our compressors as well as any other machinery with high current or even mean voltage.

BORSIG Service GmbH offers in Gladbeck/NRW 5,250 m² indoor workshop facilities, 32,000 m² open space and loading capacity up to approx. 100 t.
The manufacturing equipment comprises a UP welding system for vessels up to a diameter of 4000 mm for interior and exterior welding work, weld cladding with ribbon and wire, a UP welding system for welding in fittings, gas cutting machine, plasma cutter for material thicknesses of up to 50 mm, vessel turning system with a load capacity of up to 100 t, CNC turning machines, center lathes, vertical cutting and boring machines, ball grinding machine up to 52“ and the like.

1.2 Quality

Quality assurance and control activities are independent of the manufacturing process or product lines and guarantee that machined and handled materials, components, assemblies, products and service operations are executed in accordance with all specified requirements.

Quality assurance surveys the adherence to national and international specifications, statutory and contract provisions as well as the directives, standards and regulations stipulated by all companies of the **BORSIG Group**.
In order to ensure even better interaction between quality, work safety and environmental management, the individual management systems were merged to form an Integrated Management System (IMS).

Consistent quality monitoring from the analysis of the customer's needs to design, work preparation, construction, acceptance and handing over to the customer right through to after-sales service ensures that materials to be processed, parts manufactured, products and services are at all times in conformity with the applicable requirements.

Certificates of the BORSIG Group (Extract):

- Quality Management DIN EN ISO 9001
- Environmental Management System DIN EN ISO 14001
- Occupational Safety SCC**
- ASME U, U2, R and S
- SQL licence for PR China (Pressure Vessels A1, A2)
- AD 2000 - Directives HP 0, TRD 201 and DIN EN ISO 3834-2 and DIN 18800-7
- Certificate of Manufacturer Registration for Cylinders (Korea License)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BORSIG Group

1.3 Worldwide

For our customers' convenience the **BORSIG Group** has installed a network of representatives worldwide, with focus on the main oil and gas producing and processing countries as well as own representative offices in China and Japan.

There are the following five locations of the BORSIG Group in Germany with headquarters at the city of Berlin, capital of Germany.

Berlin: Pressure vessels, heat exchangers, power plant services including project engineering

Meerane: Reciprocating and centrifugal compressors

Gladbeck: Membrane technology, industrial services, compressors and compressor services

Rheinfelden: Membrane production, membrane technology

Flensburg: Compressor valves


BORSIG

2

BORSIG Process Heat Exchanger GmbH

Pressure Vessels and Heat Exchangers

BORSIG Process Heat Exchanger GmbH supplies pressure vessels and heat exchangers for cooling gases at very high temperatures (up to 1,500 °C) and high pressure (up to 35,000 kPa) for the chemical and petrochemical industries. These pressure vessels and heat exchangers are used for process stages in plants for the production of basic chemicals where they are installed directly at the downstream end of the cracking furnaces and/or reactors. BORSIG technology is also used in innovative coal gasification processes.
Design orientated towards practical application, highly qualified staff as well as state-of-the-art production and testing methods ensure the constantly high quality standard of our pressure vessels and heat exchangers which meet all requirements, such as stability, operational safety and long service life.
For this purpose, BORSIG Process Heat Exchanger GmbH and its manufacturing facilities are always at the forefront of the state of technology.

Our product range:

- Waste heat recovery systems (ammonia plants, methanol plants, hydrogen plants, coal gasification plants, gas-to-liquid plants, nitric acid plants, caprolactam plants formaldehyde plants, partial oxidation of oil and gas)
- Transfer line exchangers in ethylene plants
- Scraped surface exchangers for lube oil plants and special applications

2.1

BORSIG Process Heat Exchanger GmbH

Process Gas Waste Heat Recovery Systems

For more than 50 years, **BORSIG Process Heat Exchanger GmbH** has been supplying process gas waste heat recovery systems for high-temperature and high-pressure applications to the petrochemical industry. Thanks to a wealth of experience, comprehensive know-ledge, design orientated towards practical application, state-of-the-art production and testing methods and last but not least highly qualified staff, the company has become the leading manufacturer in this area worldwide. Every process gas waste heat recovery system manufactured by BORSIG Process Heat Exchanger GmbH is designed exactly in accordance with the customer's individual requirements and is provided with special design features for the various operating conditions and applications. The process gas waste heat recovery systems can be used for gas pressure values of up to 350 bar (35,000 kPa), incoming gas temperatures of up to 1,500 °C and steam pressure values of up to 160 bar (16,000 kPa).

Applications of BORSIG process gas waste heat recovery systems include:

Ammonia plants, methanol plants, hydrogen plants, coal gasification plants, gas-to-liquid plants, nitric acid plants, caprolactam plants, formaldehyde plants, the partial oxidation of oil or natural gas.

Any combinations can be integrated into any customer-specific process gas waste heat recovery system:

Reform gas waste heat boiler, steam superheater (1- or 2-stage), HT SHIFT waste heat boiler, feed water preheater, gas/gas heat exchanger, steam drum, superheated steam cooler, synthesis gas waste heat boiler, quench coolers for ethylene plants, scraped surface exchangers for lube oil plants and other special applications.


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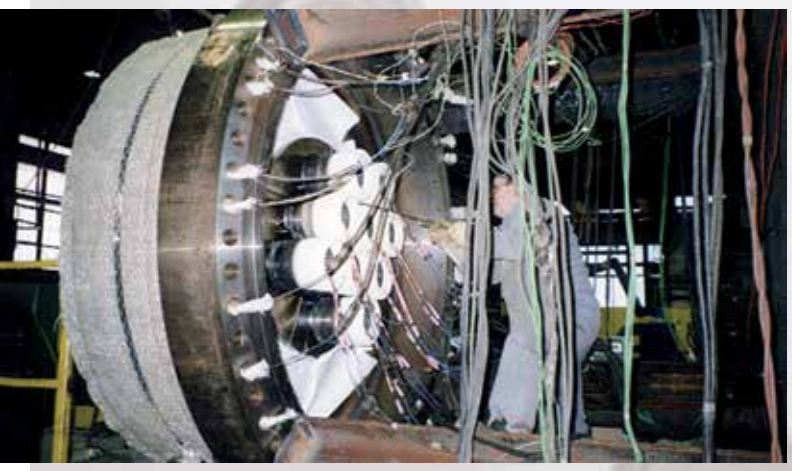
2.2

BORSIG Process Heat Exchanger GmbH

Synthesis Gas Coolers Downstream of Partial Oxidation of Oil and Natural Gas (Texaco-, Shell- and other processes)



The non-catalytic cracking of hydrocarbons by partial oxidation of natural gas, oil etc. is carried out at temperatures up to 1,500 °C and pressures up to 8,000 kPa. Besides the resulting reaction components CO, CO2, H2, H2O and H2S the process gas is loaded with soot and ash. Depending on the type of feedstock other impurities like vanadium, nickel and iron can also be expected. Due to these impurities, the high particulate burden of the gas and the hydrogen sulfide the waste heat boiler must be highly resistant to erosion, corrosion and fouling.

The process gas has an inlet temperature around 1,500 °C and an outlet temperature of about 300 °C. The heat of the gas is used to generate steam of a pressure of up to 140 bar (14,000 kPa). The heat can also be used to superheat the steam by a superheater integrated into the waste heat boiler.

Waste heat boilers can be built with a gas-side flow rate of up to 70,000 Nm³/h. The design used allows this to be easily expanded to a quantity of 200,000 Nm³/h.

BORSIG Process Heat Exchanger GmbH has developed its own boiler design with special design features for example for the most critical area of the waste heat boiler: the gas inlet section.

2.3

BORSIG Process Heat Exchanger GmbH

Waste Heat Boilers for Nitric Acid, Caprolactam and Formaldehyde Plants

Process gas coolers/waste heat boilers with direct integrated reactors are used within the production process of nitric acid, caprolactam and formaldehyde.

The feed gas is transferred to the reactor and reacts at the installed catalyst to produce the intermediate or final product. The heat that develops/originates during this process is regained by the downstream heating surfaces below the catalyst bed by heating a coolant, e.g. water.

Waste Heat Boiler Downstream of Ammonia Combustion in Nitric Acid and Caprolactam Plants

Nitric acid is produced by means of catalytic oxidation of ammonia to nitric oxides. The catalyst used is a finely woven platinum gauze with approximately 15 % rhodium. The oxidation is an exothermic process in which the gas is heated to approx. 900 °C. The process operates under a pressure of about 5 bar (500 kPa). The released thermal energy is recovered by cooling the gas to 300 °C, which in turn generates and superheats steam. Superheated steam temperatures of up to 500 °C are possible. The usual steam pressure levels are between 40 bar (4,000 kPa) and 80 bar (8,000 kPa).

The integrated waste heat boiler is of a forced circulation design to ensure the necessary compactness. The heating surfaces are either flat spiral elements or meander coil elements in a square section gas duct. Usually evaporator, superheater and economizer are arranged in one shell. In larger plants, however, the feed water preheating is sometimes outside the waste heat boiler. A different design comprises a spirally coiled superheater in front of an evaporator as a two-pass fire-tube boiler

Waste Heat Boiler Downstream of Dehydration of Methanol in Formaldehyde Plants

Among others, formaldehyde is produced by the „Silver Contact Process“. The feedstock for the reaction is a gas mixture of methanol, water and air. The reaction type is a catalytic oxy-dehydration, which heats the product gas to 600 to 700 °C.

The reactors used to produce the formaldehyde have an integrated waste heat boiler to recover the heat reaction from the gas. Saturated steam is produced when the gas cools down to 150 °C.

The waste heat boiler is designed as a fired-tube boiler. The produced steam will be delivered to the main process. The feedstock enters the reactor in the upper section with the catalyst, the product gas is cooled down in the subsequent tube bundle. Usual steam parameters for pressure and temperature are 20 bar (2,000 kPa) and 200 °C.

2.4

BORSIG Process Heat Exchanger GmbH

Waste Heat Boilers in Coal Gasification Plants

During the coal gasification at high temperatures and high pressures in the gasifier, the solid coal is converted into a synthetic gas. Depending on the licensed process used, this occurs by adding air or oxygen. The generated synthetic gas can be used for the generation of combustion gas in power plants as well as the starting product for the chemical industry.

BORSIG Process Heat Exchanger GmbH provides appropriate pressure vessels and heat exchangers for the cooling of the synthetic gas generated in the gasifier. The devices were developed especially for use at these high temperatures.

These pressure vessels and heat exchangers are designed for the use of special materials that withstand the highly corrosive and erosive application conditions.

The coal gasification usually uses a waste heat recovery system downstream of the gasifier.

This waste heat recovery system includes an evaporator for the cooling of the generated synthetic gas.

Depending on the process requirements, the waste heat recovery system can be expanded by a single stage or two-stage high temperature steam superheater and by a single stage or two-stage feed water preheater.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2.5

BORSIG Process Heat Exchanger GmbH

Transfer Line Exchangers

Transfer Line Exchangers (tunnelflow and linear quench coolers) from **BORSIG Process Heat Exchanger GmbH** are used in plants producing ethylene, an important starting material for plastics manufacturing.

Ethylene (C2H4) and some other byproducts like propylene are produced by thermal cracking of hydrocarbons in pyrolysis furnaces. This process generates so-called cracked gas. Ethane, naphtha and other mineral oil fractions are predominantly used as feedstocks.

The cracked gas, which leaves the furnace at a temperature of around 850 °C (1,500 °F), must be cooled down rapidly to 250 - 400 °C to prevent secondary reactions and to stabilize the gas composition in order to obtain the optimum product yield. This process is called „Quenching“. In all modern ethylene processes this rapid cooling of the cracked gas is performed with Transfer Line Exchangers (also known as quench coolers or TLEs), thereby producing also valuable high pressure steam that can be used e.g. for steam turbines.

There are one or more parallel TLEs per furnace cell, which are connected by riser and downcomer piping with one common, elevated steam drum thereby forming the so called quench system.

BORSIG Transfer Line Exchangers are the result of more than 50 years experience and almost 7,000 units have been supplied worldwide (as of June 2013).

BORSIG Transfer Line Exchangers are based on a proven design characterized by ease of maintenance, high reliability and long service life.

BORSIG Process Heat Exchanger GmbH has developed two design types of quench coolers, reflecting the customer`s plant concept:

- **BORSIG Linear Quencher (BLQ)**
- **BORSIG Tunnelflow Transfer Line Exchanger (TLE)**

2.6

BORSIG Process Heat Exchanger GmbH

Scraped Surface Exchangers

BORSIG Process Heat Exchanger GmbH has been producing scraped surface exchangers for more than 90 years.

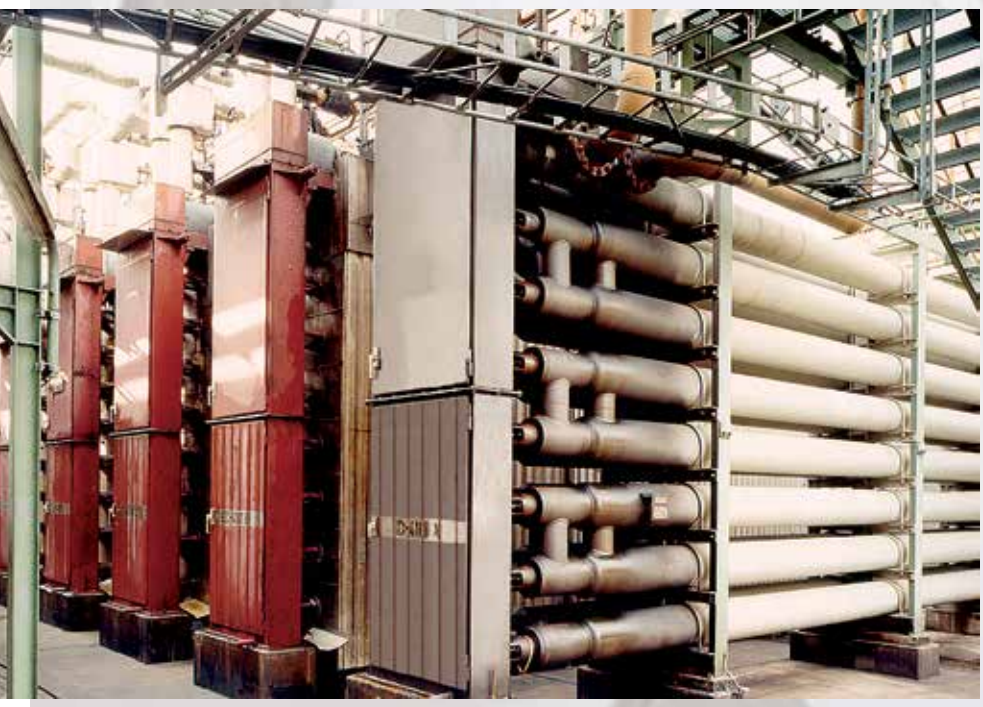
Modern design, orientated towards practical application, state-of-the-art manufacturing and testing methods and the staff's expertise add up to a high-quality scraped surface exchanger that fulfils all requirements in terms of stability, operating reliability and long service life.

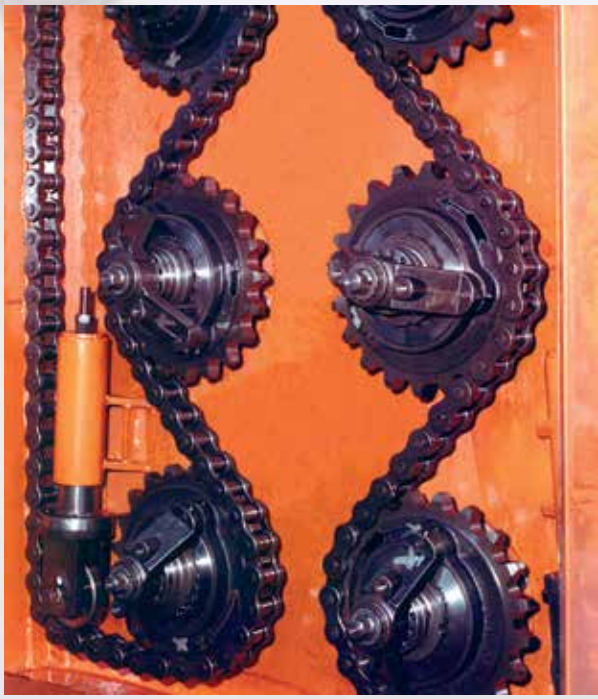
BORSIG Process Heat Exchanger GmbH supplies scraped surface exchangers for any desired throughput and thermal capacity with inside tube diameters of 6 inches, 8 inches, 10 inches and 12 inches.

Scraped surface exchangers are supplied almost exclusively as compact units, so that installation work on site is reduced to a minimum.

Furthermore, BORSIG Process Heat Exchanger GmbH supplies completely new drive systems and/or drive shafts to upgrade existing scraped surface exchangers, as well as scraped surface exchangers from other manufacturers.

Applications of the BORSIG scraped surface exchangers include de-waxing of lube oil, the oil separation from waxes, the production of cellulose acetate flakes, the manufacture of fatty acids, the crystallization of paraxylene, the continuous mixing of liquid and semi-solid products under cooling or heating conditions, heat transfer in the presence of strong product contamination of transfer surfaces as well as heat transfer with high-viscosity products.





2.7 Engineering

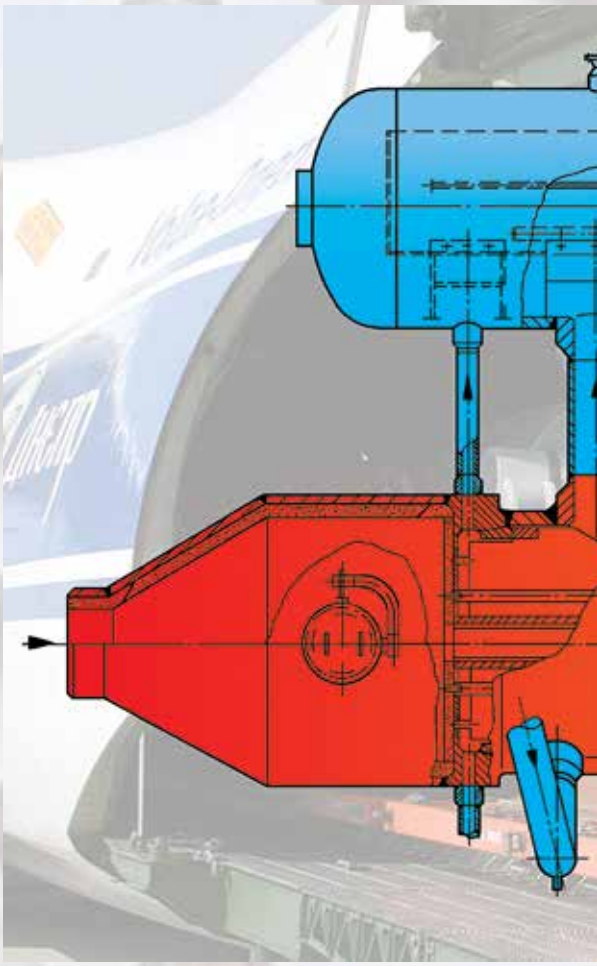
BORSIG Process Heat Exchanger GmbH has complete in-house engineering facilities. Thermal layout of heat exchangers and special heat transfer calculations are performed and checked with computer programs developed in-house. For highly complex tasks, the gas flow and heat transfer are calculated by means of three-dimensional CFD models (computational fluid dynamics).

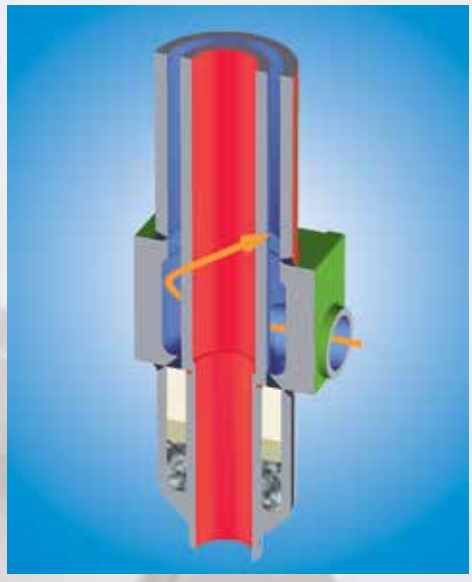
The pressure vessels and heat exchangers are calculated according to all national and international calculation regulations:

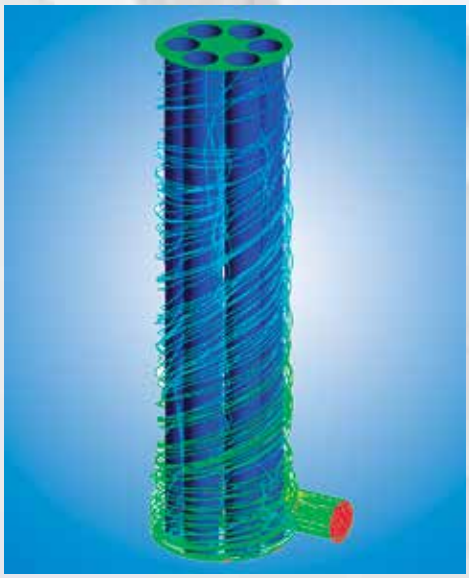
ASME CODE I, VIII Div.1 and Div.2, ASME B31.1 and B31.3, AD-2000 Merkblätter Code, TRD - Power station code, EN standards, PD 5500, CODAP, Stoomweezen, IBR, JIS, Australian Standards, China SQL.

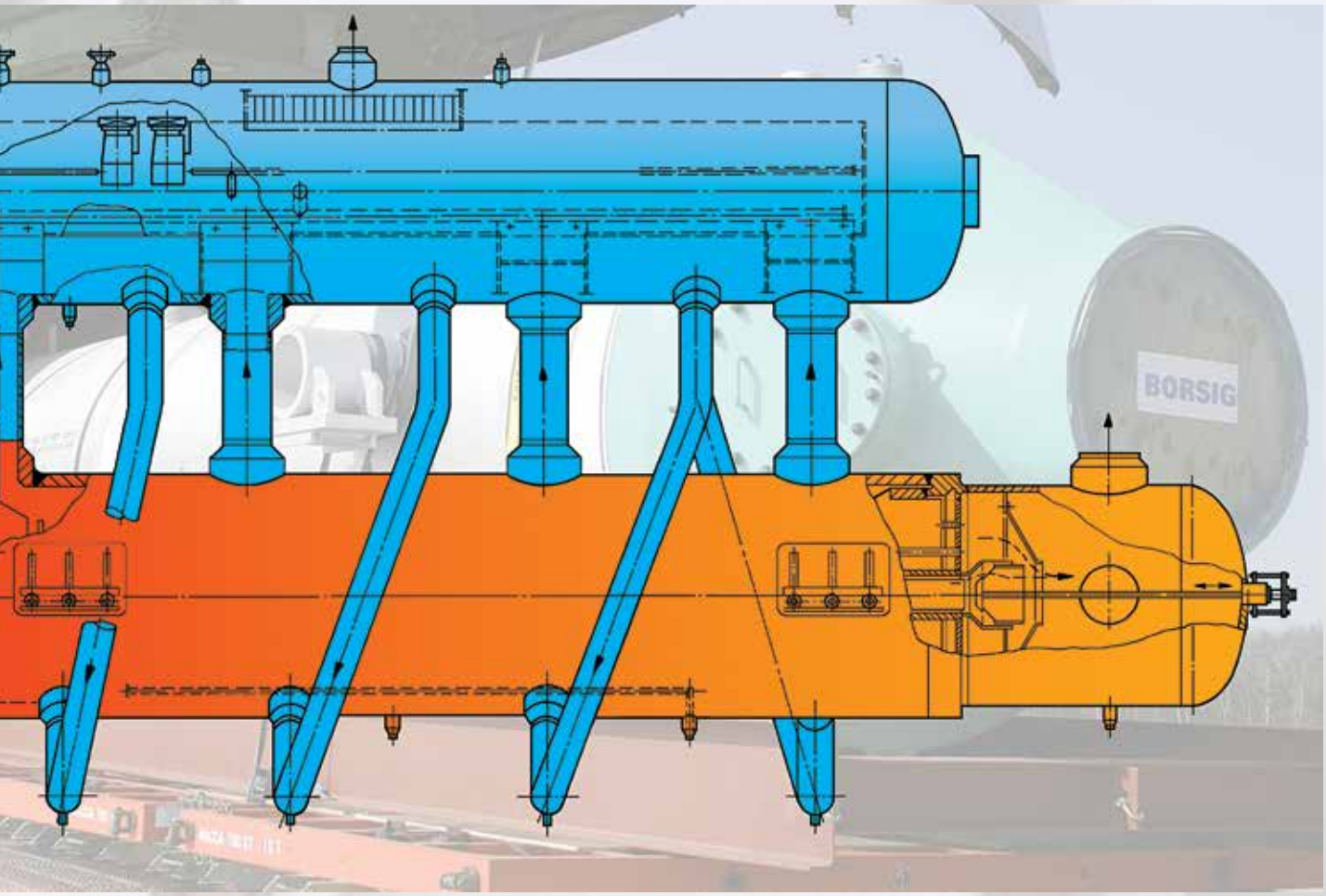
In the case of critical parts, Finite Element Analyses are carried out.

The flexibility of the tube systems, the resulting support loads and forces are calculated by a special software.





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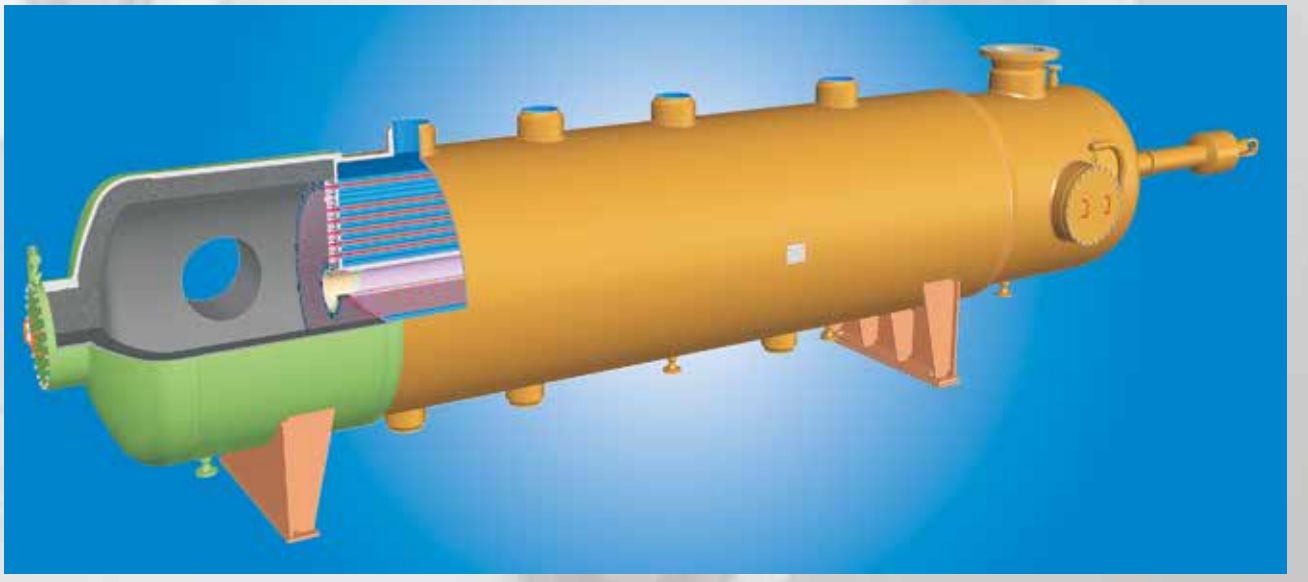


2.8

BORSIG Process Heat Exchanger GmbH

After Sales Service

The after sales service and technical product support service of **BORSIG Process Heat Exchanger GmbH** offers a wide range of spare parts and services. On request we offer a complete exchange service for pressure vessels and heat exchangers.

Our main objective is to keep the downtime of your plant to an absolute minimum. Our excellent service team is specialized for jobs like these and works out the shortest process based on a detailed engineering plan.

Our service portfolio for technical support:

- Installation planning and construction site supervision for new installations and repairs
- Root cause analysis at the location and by remote diagnostics
- Technical consultations in case of corrosion problems
- Evaluation of boiler operating water
- Consultations for preventive maintenance actions
- Review of customer procedures before the start of installations (container cleaning, welding, chemical cleaning, nondestructive material tests, brick lining)

Our service portfolio for spare parts includes:

- Preparation of spare part offer with technical order processing and delivery for maintenance or for repairs according to your requirements from one source
- The delivery of spare parts from other manufacturers (part of the original scope of delivery by BORSIG)

3

BORSIG ZM Compression GmbH

Compressors

BORSIG ZM Compression GmbH offers customized solutions according to customer specifications for reciprocating and centrifugal compressors.

Integrated concepts, from planning to design, manufacture and assembly are characteristic of our approach. BORSIG ZM Compression GmbH warrants the highest product quality thanks to competent engineering, state-of-the-art manufacturing processes and seamless quality assurance.

Mechanical manufacturing at BORSIG ZM Compression GmbH excels by considerable manufacturing depth. This enables us to respond to all kinds of customer requirements in a very flexible and fast attitude.

The production portfolio of BORSIG ZM Compression GmbH includes:

- Reciprocating Compressors for Process Gases
- Centrifugal Compressors for Process Gases
- Compressors Valves
- BORSIG BlueLine
- Compressor Services

3.1

BORSIG ZM Compression GmbH

Reciprocating Compressors for Process Gases

Based on more than 150 years of experience in reciprocating compressor manufacturing **BORSIG ZM Compression GmbH** now offers a reciprocating compressor series for most technical gases and in accordance with API 618 design standards, further international standards and manufacturers` standards.

Thanks to the high level of vertical integration in the manufacturing of compressor components, BORSIG ZM Compression GmbH is capable of transferring the high demands on the parts directly from the design onto the manufacturing process and closely monitor this process.

The 3D design tools used by BORSIG ZM Compression GmbH are state-of-the-art and provide numerous opportunities to the user: Complete visualization and design of the system, but also selective and systematic design of the parts and components.

BORSIG ZM enjoys the benefit of this diligent engineering process that provides the compressors with longer life cycles, better wear resistance and hence lower life-cycle costs.

Power ranges:

Discharge pressure:	... 1,000 bara
Capacity / flow:	... 115,000 m³/h
Power:	... 16,000 kW

Typical fields of operation:

- Chemical and petrochemical industries
- Oil and gas industries
- Crude oil recovery
- Natural gas recovery and processing, transport and storage
- Refinery technology
- Power plants
- Low-temperature engineering
- Gas liquefaction, e.g. LPG, LNG
- Various industrial processes

BORSIG ZM Compression GmbH

3.2 Centrifugal Compressors for Process Gases

BORSIG ZM Compression GmbH manufactures centrifugal compressors for process gases for more than 50 years.

The BORSIG ZM centrifugal compressor series comprises integrally geared centrifugal compressors which comply with the corresponding API design standards, such as API 617 and API 614.

The impeller is the heart of the centrifugal compressor stage. The BORSIG ZM impellers are open and closed types, designed and manufactured with state-of-the-art CAD/CAM tools.

Thus, they reach a very high efficiency. Special materials for the impellers (e.g. stainless steel or titanium) and volutes guarantee that all requirements of the process industry will be met.

Power ranges:

Discharge pressure: ... 80 bar [1)]
Capacity / flow: ... 100,000 m³/h [2)]
Power: ... 12,000 kW

[1)] higher pressures on request
[2)] higher capacity/flow on request

Typical fields of application:

- Chemical and petrochemical plants
- Oil and gas industries
- Refineries
- Fuel-gas delivery for gas turbine systems
- Various industrial processes

3.3

BORSIG ZM Compression GmbH

Compressor Valves

BORSIG ZM Compression GmbH offers a wide range of products and services in the field of compressor valves by its subsidiary **BORSIG Compressor Parts GmbH**.

For more than 25 years BORSIG Compressor Parts GmbH deals with the development, production, processing and modification of compressor valves and thus continues the BORSIG tradition in the compressor valve technology.

BORSIG Compressor Parts GmbH has already analyzed hundreds of reciprocating process gas compressors. As a result, about 35 % of the existing and new compressors could be optimized.

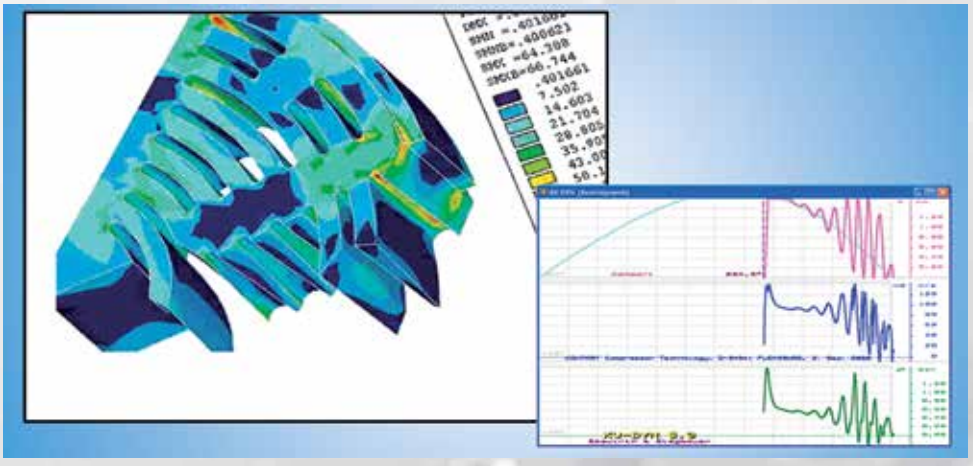
Based on these findings, the orientation towards our customers specific requirements and the continuous development of our acquired know-how have led us to new products such as systems to diagnose reciprocating compressors.

Our long-lasting experience has shown that a reliable compressor and valve analysis is often able to solve the customer´s problems only by recalculating and modifying the existing parts.

The BORSIG team of experienced engineers guarantees a service, which is always close at hand so that we can quickly analyse and solve problems of reciprocating compressors.

Products and Services at a glance:

- Engineering and manufacturing of valves for different services
- Actuators for capacity control
- Damage analysis, valve reconditioning and modification
- Spare parts for compressor valves of all common types
- Software to analyse compressors and valves
- Oil scraper packings in cartridge design for problem-free installation
- Testing of valves



3.4

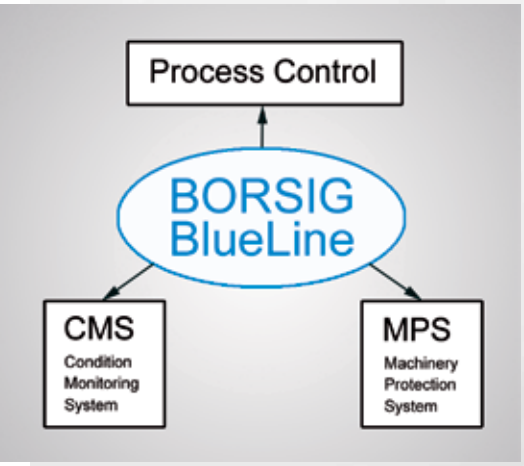
BORSIG ZM Compression GmbH

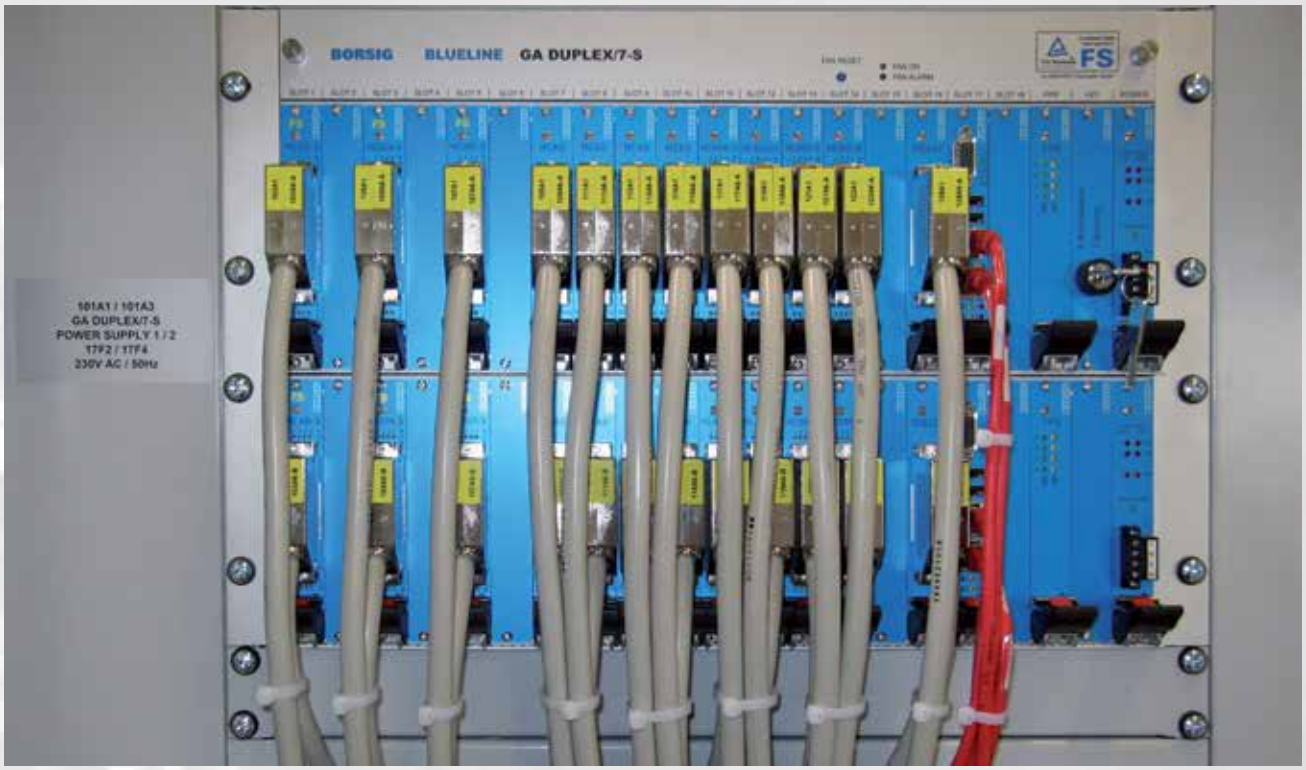
BORSIG BlueLine

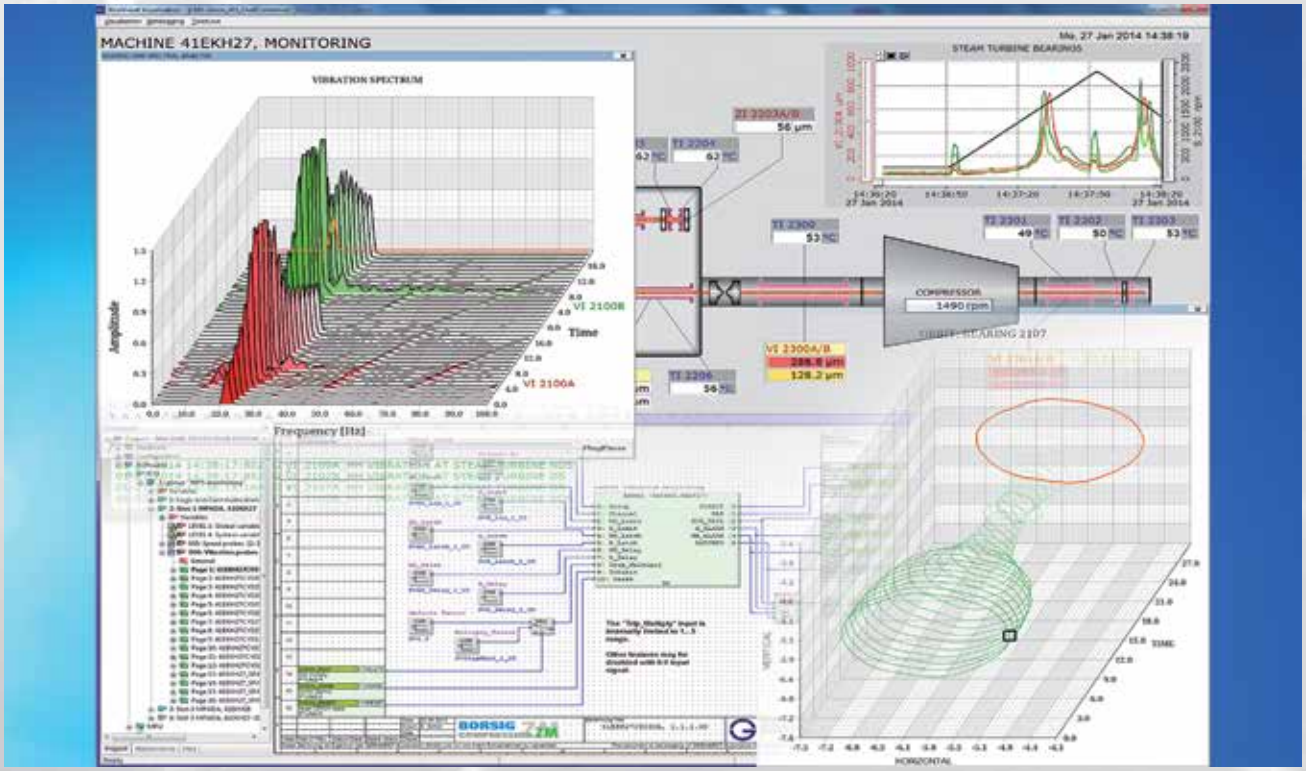
The BORSIG BlueLine combines control system, machine protection and condition monitoring for reciprocating and centrifugal compressor units by **BORSIG ZM Compression GmbH** as well as by other manufacturers.
The BORSIG BlueLine system family is the basis for integrated SIL3 automation. Safety-related communication and processing with, if required, multiple redundancies enable the efficient distribution of complex applications and the integration of several systems.
In addition to regular automation, modern plants require an increasing amount of certified safety functions. BORSIG Blue Line systems allow the mixed operation of certified safety components (up to SIL3) with standard automation systems in one computer system. The transparency between these components is guaranteed.

Features of BORSIG BlueLine:

- Highest safety, certified up to SIL3 (IEC61508, IEC61511, IEC62061) and PL e and CAT 4 (ISO 13849, DIN 954) for open-loop and closed-loop control
- Highest system availability by redundancy up to quadruple and hot swap component replacement
- Hardware diagnostics of all I/O signals with error detection
- Mixed configuration of certified safety, measuring and control systems possible
- Integrated Machinery Monitoring System (MMS) consisting of Machinery Protection System (MPS) and Condition Monitoring System (CMS)
- Strict separation of MPS, SPS and ESD not required
- Full integration of the 3 systems PLC, MPS and CMS, however, also available as individual module
- Low space requirements and reduction of interfaces
- Freely programmable with SIL3 certified function blocks
- Open communication interfaces: Open Modbus TPC, RTU Modbus, others on request
- Process visualization system with integrated, high-resolution recording of the process data and sequences




BORSIG BLUELINE GA DUPLEX/7-S
101A1 / 101A3
GA DUPLEX/7-S
POWER SUPPLY 1 / 2
17F2 / 17F4
230V AC / 50Hz


MACHINE 41EKH27, MONITORING
VIBRATION SPECTRUM
Amplitude
Time
Frequency [Hz]
STEAM TURBINE BEARINGS
COMPRESSOR
1490 rpm
BORSIG ZM

3.5

BORSIG ZM Compression GmbH

Compressor Services

As a leading manufacturer of compressor systems worldwide, **BORSIG ZM Compression GmbH** offers you a comprehensive service from one source. Our after sales service takes care for your concerns flexibly and efficiently, whether you require service for a BORSIG ZM product or for compressors made by other manufacturers.
Competence based on long-time experiences in the field of compressors and the high quality of our services makes us the partner you can rely on.

Portfolio of services

- Installation and commissioning of compressor units
- Spare parts management
- Revamp and refurbishment engineering
- Maintenance and repair
- In-house and on-site training
- Valve service and engineering

Portfolio of products

- Reciprocating Compressors for Process Gases
- Centrifugal Compressors for Process Gases

24-hour service hotline
Phone: +49 3764 5390 5120
E-mail: service@zm.borsig.de

Based on its own engineering, BORSIG ZM provides support from the installation and commissioning of the machine and equipment to the revamp, modification and modernization. To keep the system availability on a high level, a comprehensive maintenance service is provided.

In emergency cases short reaction times are required. BORSIG ZM´s service staff is available for its customers, 24/7 and worldwide.

A wide range of constantly available spare parts together with short manufacturing times and high quality standards guarantee a minimal downtime of your compressor.


BORSIG ZM

4

BORSIG Membrane Technology GmbH

Membrane Technology

BORSIG Membrane Technology GmbH is an internationally successful company offering innovative membrane technology solutions to its customers for a wide range of industrial applications.

Our products - membranes, membrane modules and complete membrane systems - represent high quality, competence and reliability. Our product portfolio includes process simulations, the delivery of complete turn-key systems and comprehensive services.

Under consideration of the highest safety and quality requirements, our membranes, membrane modules and membrane systems guarantee a safe plant operation and permit maximum efficiency factors and optimum cost effectiveness for the following application segments:

- Emission Control
- Product Recovery
- Gas Separation
- Gas Permeation
- Organic Solvent Nanofiltration

Our employees offer intelligent process solutions for more than 20 years. At the two locations in Gladbeck/ NRW and Rheinfelden/Baden-Württemberg, our highly qualified teams work with state-of-the-art membrane production processes and engineering tools.

In addition to our innovative standard solutions, we offer customized solutions for new processes especially for your requirements or support for the optimization of already existing processes. Throughout our operational processes, we control and optimize the entire production process and therefore the quality and adherence to schedules. Quality assurance, occupational health and safety as well as environmental protection are of utmost importance to us and our employees therefore coordinate independently all work steps such as the technical specifications, procurement, production, installation and commissioning.

With the experience of hundreds of delivered membrane systems on an industrial scale, BORSIG Membrane Technology GmbH is the competent partner for your products.

BORSIG Membrane Technology GmbH

4.1 Emission Control

Volatile Organic Compounds (VOC) are part of the hydrocarbon family with the respective vapor pressure and they occur naturally or are produced industrially. In many processes in the chemical, petrochemical and oil and gas industries, the use of such compounds produces the release of the respective VOC emissions, e.g. through evaporation, displacement or flushing processes.

The use, the storage and the handling of solvents and benzines have become one of the largest VOC emission sources. Large volumes of organic vapors are emitted through displacement and evaporation effects, in most cases as a mixture of air or oxygen with the organic components.

Typical products include
- Solvents
- Benzines
- Additives
- Diesel, jet fuel
- (Bio) Alcohols
- Bio fuel
- Crude oil

Therefore, appropriate technical rules and laws were implemented worldwide to significantly reduce the VOC emissions by reducing the consumption and by installing appropriate emission control systems.

BORSIG Membrane Technology GmbH offers many solutions for the emission control and for all internationally known emission standards.

These solutions provide highest efficiency factors (<99.9 %) and they satisfy all safety and quality requirements with a high reliability.

Our product offering includes:

BORSIG ***Vapour Recovery Unit***
VOC Emission reduction for tank farms, ship loading and refineries

BORSIG ***Carbon Retrofit Unit***
Retrofit of existing active coal system for the recovery of vapors

BORSIG ***Vent Recovery System***
Additional emission control for gas stations

BORSIG ***Hydrocarbon Recovery Unit***
Recovery of valuable hydrocarbons

BORSIG Membrane Technology GmbH

4.2 Product Recovery

Product recovery systems must increasingly fulfill higher requirements with respect to their performance. Economic efficiency, high productivity, proven sustainability of the process used and an optimal utilization of the resources used are some of the challenges that must be fulfilled in this industrial segment.

BORSIG Membrane Technology GmbH provides optimized process related solutions that are qualified to minimize product losses and to recover valuable feedstocks from the exhaust air or the process gas flows and to return them into the production cycle. This permits the recovery of valuable feedstocks and products as well as the significant reduction of waste and exhaust air volumes.

Major products and applications include

- Ethylene monomer from the production of polyethylenes (HDPE, LDPE, etc.), ethylene oxide (EO) or VAM
- Propylene monomer from the production of polypropylene (PP)
- Solvents (Butane, pentane, hexane, etc.), e.g from a slurry type production, vinyl chloride monomer (VCM) from the PVC production
- Aromates (benzol, toluol, xylene, etc.) from production and storage
- Additives such as MTBE, ETBE
- Hydrochlorofluorocarbons from the respective processes
- Alcohols, methanol, ethanol
- Bio-fuels from production and storage

Our product offering includes:

BORSIG ***Ethylene Recovery Unit***
Ethylene monomer recovery in the polyethylene (PE), ethylene oxide (EO) and VAM production

BORSIG ***Hydrocarbon Recovery Unit***
Recovery of valuable hydrocarbons

BORSIG ***Propylene Recovery Unit***
Propylene monomer recovery in the polypropylene (PP) production

BORSIG ***Nitrogen Recovery Unit***

BORSIG ***Organic Solvent Nanofiltration***

BORSIG Membrane Technology GmbH

4.3 Gas Separation

In a large segment of industrial applications, e.g. in the oil and gas industry as well as the chemical and petrochemical industry, **BORSIG Membrane Technology GmbH** offers the opportunity to treat gases in the oil and gas production in a targeted manner to, for example, condition crude gas or to improve the quality of product flows.

This may include gas specification, pipeline specification or calorific values provided by the customer.

The required gas quality is defined typically by the methane content, pressure dew point, calorific value or a minimum methane number and it correlates in most cases with the content of higher hydrocarbons (C3+), carbon dioxide (CO2) or oxygen (O2).

BORSIG Membrane Technology GmbH offers the following products:

BORSIG ***Fuel Gas Conditioning***
Gas conditioning for pipeline, gas motor and turbine applications

BORSIG ***Carbon Capture***

BORSIG ***Biogas Processing***
Membranes and systems for the biogas treatment

BORSIG ***Hydrogen Separation***

BORSIG ***Oxygen Enrichment***
Oxygen enrichment for combustion processes

BORSIG ***Seal Gas Recovery***
Leakage gas conditioning for compressor and expander systems

4.4

BORSIG Membrane Technology GmbH

Membrane Services

The worldwide customers of **BORSIG Membrane Technology GmbH** trust the know-how present in the engineering and service segment. We offer complete service packages as well as customized services for companies in the oil and gas industry, in refineries, tank farms and in the petrochemical industry. Our service team is trained in accordance with SCC and VCA and it consists of experienced, highly qualified engineers and technicians who are assigned to the plants and installations worldwide.

We know exactly what is important thanks to our broad experience of the service for industrial plants and the required cross segment competence in process engineering, in plant engineering, in control systems as well as explosion protection. It is our objective to increase the availability and productivity of your plants, to reduce environmental impacts and to lower your maintenance costs significantly.

We offer reliability, cost-effectiveness and protection of your assets. We can provide or coordinate all services with our own staff and we are therefore capable of utilizing all synergies optimally.

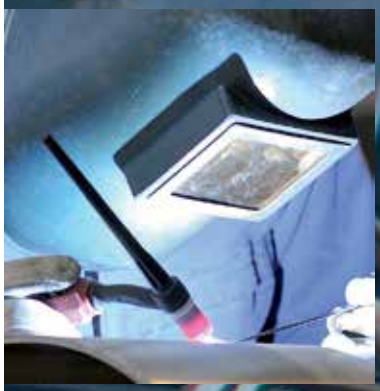
The basic prerequisites for a high plant efficiency and the prevention of unscheduled downtimes include regular inspections and the reviews of all functions and plant components by competent experts. Innovative measurement and analysis methods help to prevent errors and failures.

By utilizing software supported systems for maintenance and service planning, we develop strategies for your special application to execute a perfectly coordinated and cost saving maintenance in appropriate intervals.

Our service portfolio:

- Process development and optimization
- Basic and detail engineering
- Process control and visualization
- Operator training
- Customer service, maintenance and trouble-shooting
- Maintenance and repair for steam recover plants of third party suppliers
- Plant specific maintenance contracts and spare parts management
- Standby service and remote service for software updates and analyses
- Process optimization in existing plants and systems
- Hazard and operability studies (HAZOP) for VRU of BORSIG and third party suppliers as well as for other plants and systems, IPF analysis
- Pressure container tests in cooperation with the responsible public authorities
- Performance tests of BORSIG and third party supplier plants and systems including gas, emission and capacity measurements, gas analyses
- Emission reports for refineries and tank farms

5



BORSIG Service GmbH

Power Plant and Industrial Services

BORSIG Service GmbH offers comprehensive services for the power engineering, chemical and petrochemical industries as well as oil, gas and water supply.
From our facilities in Germany – Berlin, Gladbeck, Hamburg – our exellently networked global team of engineers and technicians provides you with competent, fast and reliable support. We have decades of experience in planning, performing and implementing all kinds of assembly, manufacturing and service tasks.

We rectify malfunctions and procure any required spare parts. We support you in the planning, delivery and installation of new components in your systems, modification, inspection and maintenance of existing components provided by us or third parties, and we also offer troubleshooting within the framework of a 24-hour standby service.

In addition, our „Project Engineering“ department is able to offer technically complex modifications with thermal calculations and project-specific engineering, for example to improve the output and/or efficiency of your steam generator. We draw on the know-how of BORSIG Boiler Systems GmbH with over 9,800 designed and delivered boiler systems.

Competent, fast and close to the customer - our efficient service and installation team makes this claim a reality.

5.1

BORSIG Service GmbH

Power Plant Services

With more than 160 years of experience in the construction of steam generators, **BORSIG Service GmbH** offers the competence necessary for full-scale services in the field of energy and steam generation plants and systems.

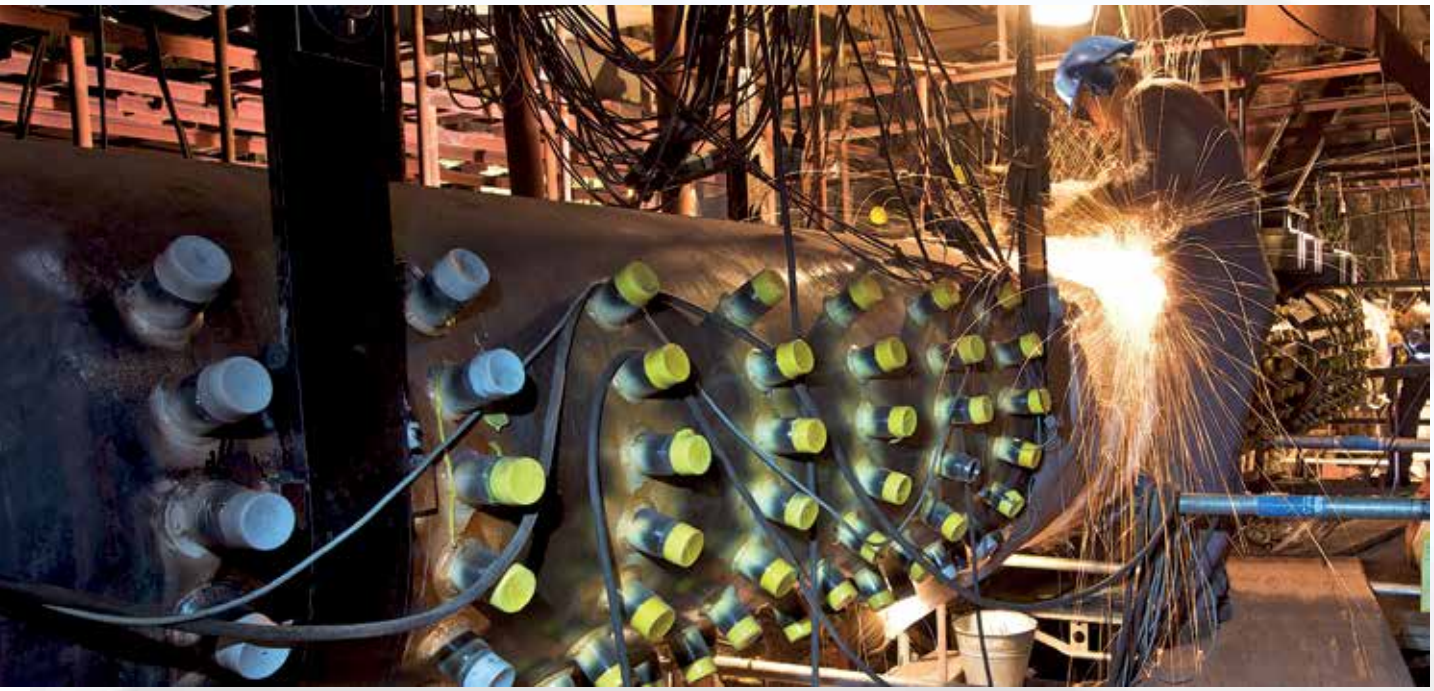
Our services in detail:

- Repair, maintenance and modification work
- Ongoing maintenance
- Installation and dismantling
- Co-ordination of external contractors
- Performing measurements, analyses and acceptance procedures
- Delivery of spare parts and exchange components according to third-party drawings or our own design
- Design of boiler modifications and retrofits with 2D and 3D CAD systems
- Overseeing boiler and power plant technology investment projects
- 24-hour standby service

Components processed:

- Steam generators
- Low pressure/high pressure heat exchangers
- Pressure vessels and heat exchangers
- Containers
- Pipelines
- Air and flue gas systems
- Soot blowers
- Charging/waste charging
- Ash removal/wet slag removers
- REA plants
- DENOX plants

Personnel from the German facilities in Berlin, Gladbeck and Hamburg and branches close to the customer are available for work in Germany and abroad. Additional capacity requirements can be covered by partners with whom BORSIG Services has been cooperating for many years on a trustful basis.



5.2

BORSIG Service GmbH

Project Engineering

The **Project Engineering** field, which originated at BORSIG Boiler Systems GmbH, is part of our core competencies today. The extensive experience of our specialists comes to you with a comprehensive knowledge in the field of pressure vessels, steam, water and energy in order to solve any kind of engineering tasks.

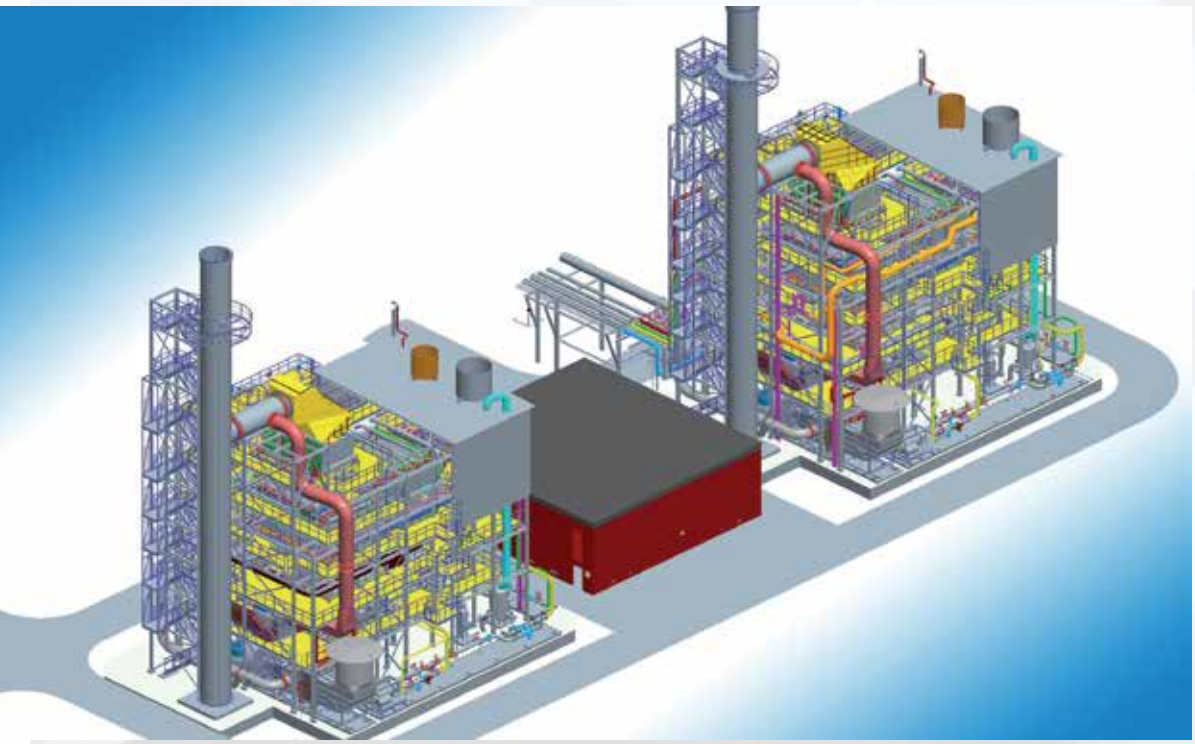
Our Engineering Services offering is primarily directed at:

- Power plant operators
- Industrial companies
- Plant manufacturers
- Engineering consultants
- Waste disposal companies
- Utilities
- Contracting companies

Our main focus is on:

- Developing concepts for comprehensive boiler modifications and retrofits, upon request with output and efficiency increases
- Performing thermotechnical calculations and process technology designs
- Performing measurements, analyses and acceptance procedures
- Performing design work with powerful 2D and 3D CAD systems
- Developing concepts for investment projects in the field of boiler construction and peripheral systems

Our high level of expertise and flexibility and a consistent focus on the customer ensure a high level of quality and reliability for all tasks.



5.3

BORSIG Service GmbH

Industrial Services

The Gladbeck facility of **BORSIG Service GmbH** offers all the necessary workshop equipment and qualified staff for the construction and general overhaul of apparatuses for the chemical and petrochemical industries and for power engineering applications.

Pressure Vessels / Heat Exchangers
General overhaul, modification, repair, inspection, maintenance, service, trouble-shooting for waste heat recovery systems, heat exchangers, transfer line exchangers, replacement pipe bundles, collectors, coolers and special pressure vessels and heat exchangers for the chemical and petrochemical industries

Ball Valves / Fittings
Maintenance and repair of ball valves with diameters of 25 to 2,600 mm/DN 1“ to 104“ as well as safety and control valves, flaps and gate valves

Machines
Comprehensive service for compressors, pumps and blowers

Plant / Pipelines
Service for pipelines in power stations, industrial plants and municipal utilities

Workship Services
Mechanical processing and new construction of spare parts, repair and manufacture of pressure vessels and heat exchangers (low-pressure and high-pressure) as well as pre-assembly of plant components

Compressors

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LEADING TECHNOLOGY FOR INNOVATIVE SOLUTIONS

Power Plant and Industrial Services

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