BORSIG Process Heat Exchanger GmbH, a member of the BORSIG Group, is the international leading manufacturer of 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.

Our comprehensive know-how is based on more than 175 years of company history. The resulting competence, the perfectly trained specialists and our awareness of quality are the basis for the reliability of our products. This symbiosis is the source of our innovative power which is reflected by our unique manufacturing program. State-of-the-art technology, excellent employees and innovative engineering allow us to always offer our customers the perfect solution. Our products and our service have made and still make us a competent and reliable partner to numerous companies across the world.

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
BORSIG Process Heat Recovery GmbH has supplied temperature and pressure process gas waste heat boilers for the petrochemical industry for more than 40 years.

A proven design, highly qualified personnel and modern manufacturing and testing methods ensure a high quality standard of our pressure vessels to meet all requirements with regard to stability, operational reliability and service life.

The process gas waste heat boilers are of own process layout and with BORSIG’s unique design features.

Applications for these process gas waste heat boilers with thin flexible tubesheet design are:

- Ammonia plants
- Hydrogen plants,
- Styrene plants,
- Oxo-alcohol plants,
- Coal gasification plants,
- Sulphur recovery plans (Claus units), and others.

Process Gas Waste Heat Boilers with Thin Flexible Tubesheet Design

Compact unit arrangement of WHBs and steam drum in a Claus unit

Waste heat boiler and steam drum in a hydrogen plant

Installation of a waste heat boiler
In process gas WHBs designed with thin flexible tubesheets, the tubes act as stays between the tubesheets and elongate due to the pressure load on the tubesheets and due to the temperature difference between tubes and shell.

As this is a physical principle, it is independent of the design and the supplier.

As this load is not mainly transferred into the shell, the tubesheets bend in the circumferential area between tube bundle and shell. The bending causes fatigue in this area. Therefore the tubesheets are subject to rigorous stress analysis and low cycle fatigue calculations. Due to the complex shape and possible elongation it is mandatory to perform a rigorous 3-D FEM analysis of the tubesheets.

BORSIG Process Heat Recovery GmbH has performed such computer simulations under consideration of all possible loads like internal and external pressure, stresses caused by temperature differences, elongation and bending moments etc.

Temperature distribution for a WHB under operating conditions
The tubes are connected to the tubesheet by a full penetration weld by an automatic welding machine, computer controlled by orbital program. No crevice corrosion can occur as there is no gap between tube and tubesheet.

Root pass of tube to tubesheet weld is obtained by fusing edge of tube to edge of tubesheet with filler wire with shield gas to avoid any crevice on waterside. Then multiweld layers are applied.

As the tube to tubesheet weld is located on the waterside of the tubesheet, its temperature during operation of boiler is close to the boiling temperature on the waterside.

Advantages of full penetration, crevice free tube to tubesheet weld:
- full penetration
- automatic machine weld
- small weld volume, small heat-affected zone
- well performed root pass, gap is impossible
- crevice corrosion is impossible
- notch-free
- quality of weld can be checked by spotwise x-ray examination
- weld is located on waterside of tubesheet, temperature is close to boiling temperature.
Design Features

1) Automatic machine welded full penetration tube to tubesheet weld.
2) BORSIG’s patented gas side bypass valve.
3) Ferrules at gas inlet of tubes protect the tubesheet and the tube to tubesheet weld from high gas inlet temperatures.
4) Full penetration tube to tubesheet weld making crevice corrosion impossible.
5) Heat shield: For safety reasons a heat shield (liner) on the tubesheet refractory is provided to keep the refractory in position in case of cracks.
6) A liner is inserted into the bypass tube. The liner and a ceramic insulation material are protecting the bypass tube from the high gas temperatures.
7) Material selection: BORSIG Process Heat Exchangers GmbH has a great experience in choosing the required material to avoid failures due to hydrogen embrittlement or metal dusting.

8) Natural circulation between waste heat boiler and steam drum: Downcomer and riser piping will be designed to achieve a sufficient circulation ratio.

9) Quality assurance and control activities are independent of the manufacturing process and warrant that the machines and handled materials, components and products are in accordance with all specified requirements.

10) Refractory in gas channels and on the gas inlet tubesheet: BORSIG has a great experience in designing refractory layers to avoid dew pointing and to achieve the specified surface temperature.

11) The thin flexible tubesheet is welded to a forged ring. Rigorous mechanical strength and heat transfer calculations are performed using FEM analysis.
Gas Side Bypass Valve

To maintain a constant gas outlet temperature with clean and fouled condition of heat exchange surface as well as during start-up and shut-down operation with reduced gas flow, exact control of the gas outlet temperature is essential.

The patented BORSIG bypass valve design - so called internal forced flow - allows exact control of the gas outlet temperature with only one control operation by adjusting the shaft horizontally. The valve changes simultaneously the flow through the bypass as well as through the tubes in the range from 0 to 100%.

Good mixing of the flow through the bypass and the tubes is obtained by the conical partition plate.

The bypass system can be adjusted to bypass 100% of the gas flow. This can be required for certain operating conditions, i.e. start-up.

We are supplying our bypass design for hot gas temperatures up to 1200°C and for gas pressures up to 11,000 kPa.
Engineering and Supervision at Site

BORSIG Process Heat Exchanger GmbH has complete inhouse engineering facilities. Thermal layout and special heat transfer calculations are performed and checked with inhouse developed computer programs. For complex problems the gas flow and the heat transfer are calculated by three dimensional finite element programs (computational fluid dynamics).

Physical properties, which are required for thermal layout, are calculated by our inhouse computer program based on the given gas composition. For special cases a process simulation program is available at our office. Flexibility, rooting, foundation loads and forces and interconnecting piping are calculated by computer programs. Calculations of pressure vessels and heat exchangers are performed according to all worldwide established codes like AD, TRD, ASME, BS, Raccolta VSR, Codap, Stoomwezen, IBR, JS, Australian Standard and others. Critical components are subject to additional strength calculations by using the finite element analysis.

Supervision at Site

Experienced BORSIG supervisory engineers are available for site construction and commissioning.
An instruction manual covering erection, start-up and maintenance will be provided for each job.
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 any overall size can be transported easily on the water way.

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 BORSIG Process Heat Exchanger GmbH.

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 Process Heat Exchanger GmbH (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, etc.