BORSIG

SYNLOOP WASTE HEAT BOILER IN AMMONIA PLANTS
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 Exchanger GmbH has been supplying high temperature and pressure process gas waste heat recovery systems for the petrochemical industry for more than 50 years. Our satisfied customers all over the world and our wide range of experience and engineering know-how together with our unique design features have given BORSIG its reputation as leading and most competent manufacturer for process gas heat recovery systems in the world.

More clients decide in favor of BORSIG Process Heat Exchanger’s HOT/COLD tubesheet design for synloop waste heat boilers for their waste heat recovery systems in ammonia plants, as they are aware of the following advantages:

- Unique patented HOT/COLD BORSIG tubesheet design
- Use of ferritic tubes
- Hydraulic expansion of tubes through thickness of tubesheet
- Internal gas inlet chamber
- Tubesheet temperature is below temperature, where nitriding starts
- No stress corrosion cracking
- No crevice corrosion
- No welding overlay of gas inlet channel against hydrogen attack and nitriding

1. Ferritic tubes are used, which are not sensitive to stress corrosion cracking, contrary to Incoloy tubes
2. Unique patented HOT/COLD tube arrangement which results in tubesheet temperatures below from where nitriding starts
3. Hydraulically expanded tubes avoid crevice corrosion
4. Hot incoming gas is guided through internal gas chamber directly to tube inlet ends, no special protection of combined gas inlet/outlet chamber against nitriding and hydrogen embrittlement is necessary
U-tubes with hot and cold ends are alternately arranged. The hot shank is surrounded by cold shanks.

Advantage of this design is that the tubesheet and the hot end tube wall temperature inside the tubesheet can be kept below 380 °C to avoid nitriding and to use ferritic tubes.

As a result the inlet ends of the tubes inside the tubesheet as well as the whole tubesheet itself are at gas outlet temperature.

The U-tubes are arranged in such way that each inlet is located adjacent to an outlet end. Inlet end ferrules protude approx. 50 mm from the thick tubesheet into the channel and are fitted to a dummy tubesheet, which is connected to an internal gas chamber of incoloy for the hot incoming gas.
Conventional Tube Arrangement Compared to HOT/COLD Tube Arrangement

The diagram on the right side indicates the temperature distribution across the tubesheet thickness. With conventional tube arrangement the tubesheet temperature will be above the temperature, where nitriding starts.

But BORSIG Process Heat Exchanger GmbH’s unique HOT/COLD tube arrangement achieves an even temperature distribution across tubesheet thickness, which is below nitriding temperature. This HOT/COLD tube arrangement is the best technical solution.
To reduce investment costs, BORSIG Process Heat Exchanger GmbH is prepared to offer a design of a synloop waste heat boiler with integrated BFW-preheating section.

The BFW is entering the BFW section close to the bottom of the tubesheet and is passing through it in counterflow to the converter effluent, is heated up close to saturation temperature and is entering the evaporation section. Then the steam/water mixture is flowing upwards through the cone and “chimney”. Above the upper end of the “chimney” an impingement plate is arranged to force droplets and water to flow down to the water hold-up volume. The steam leaves the synloop boiler by passing a demister. The downflowing water is guided through an annular space to the tubesheet. At tubesheet the water flows radially to the center part and flows upwards by generating steam.

The arrangement of BFW-section, water jacket and cone with chimney ensures that up-flowing water/steam mixture and downflowing water are separated. This circulation is a natural circulation and the tubesheet is flushed by cooling radial incoming down-flowing water. Therefore no pool boiling areas in the center of the tubesheet are present.
SYNLOOP WASTE HEAT BOILER AND STEAM SUPERHEATER

Fig. 1: Tube bundle of steam superheater
Fig. 2: Tube to tubesheet welding
Fig. 3: Tube bundle of Synloop WHB
Fig. 4: Synloop WHB ready for shipment
Fig. 5: Steam superheater ready for delivery
Typical Layouts and Arrangements

Fig. 1: Synloop WHB with integrated steam drum
Fig. 2: Synloop WHB - horizontal design
Fig. 3: Synloop WHB - designed as reboiler
Fig. 4: Arrangement of reformed and synthesis gas waste heat boilers with one common steam drum
Fig. 5: Synloop WHB with steam drum designed as compact unit
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:


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

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

Fig. 1: Finite element model
Fig. 2: Temperature distribution
Fig. 3: Stress analysis
Fig. 4: Stress analysis of tubesheet
Fig. 5: Temperature distribution of tubesheet
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.
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.
The after-sales service and technical product support service of BORSIG Process Heat Exchanger GmbH offers a wide range of spare parts 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
- Damage analysis and cause determination 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:**
- The delivery of spare parts for maintenance
- The delivery of standard spare parts and special designs for repairs
- The delivery of spare parts from other manufacturers (part of the original scope of delivery by BORSIG)
Fig. 1: Synloop WHB on site
Fig. 2: Lifting of a synloop WHB on site
Fig. 3: Positioning of a synloop WHB on site
Fig. 4: Positioning of a synloop WHB on site