

BORSIG

BORSIG
PROCESS HEAT
EXCHANGER
GMBH

TRANSFER LINE EXCHANGERS FOR ETHYLENE CRACKING FURNACES



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“Tunnelflow” Transfer Line Exchanger



Process gas waste heat boiler



ABOUT BORSIG PROCESS HEAT EXCHANGER GMBH

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 workshop in Berlin



Scraped Surface Exchanger



TRANSFER LINE EXCHANGERS

Ethylene is the basic product for the fabrication of plastics. Ethylene (C_2H_4) and some other byproducts like propylene are produced by thermal cracking of hydrocarbons in pyrolysis furnaces in the presence of steam. Predominantly ethane, naphtha and other mineral oil fractions are used as feedstocks.

The gas produced by cracking, which leaves the furnace at a temperature of around $850\text{ }^{\circ}\text{C}$ ($1,500\text{ }^{\circ}\text{F}$), must be cooled down rapidly (quenching) after leaving the reaction zone of the furnace to prevent secondary reactions and to stabilize the gas composition in order to obtain the optimum product yield. In all modern ethylene processes this rapid cooling of the cracked gas is done with Transfer Line Exchangers (also known as quench coolers or TLEs) thereby producing high pressure steam.

There are one or more parallel TLEs per furnace cell, which are connected by riser and down comer 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 about 7,500 units have been supplied worldwide between 1965.

Manufacturing of "Tunnelflow" Transfer Line Exchangers



An up-to-date, tailored-to-practice design, modern manufacturing and testing methods and the special know-how of our personnel ensure a high-quality quench cooler meeting all today's requirements with regard to mechanical and operational reliability. These advantages, sound workmanship and meeting of the performance guarantees, have gained the BORSIG Transfer Line Exchanger a high reputation at home and abroad.

After delivery and commissioning an efficient after sales service is a matter of course for us.

BORSIG Process Heat Exchanger GmbH offers two different patented designs:

- BORSIG "Tunnelflow" Transfer Line Exchanger
- BORSIG "Linear" Transfer Line Exchanger.



Transfer Line Exchangers at the works area

Manufacturing of "Linear" Transfer Line Exchangers



“TUNNELFLOW” TRANSFER LINE EXCHANGER - ARRANGEMENTS

Vertical

The most common arrangement of the quench system is shown in Fig. 1.

This vertical arrangement of one or more TLEs, which are serving one common elevated steam drum, is in most cases the only feasible arrangement in connection with the furnace cell. The location is in most cases on top of the radiant section of the furnace.

Horizontal

True horizontal arrangement of the BORSIG “Tunneflow” Transfer Line Exchanger is also possible if desired by the ethylene furnace designer.

The steam drum can in this case either be arranged piggy back mounted on top of the quench cooler or at an elevated location in the steel structure.

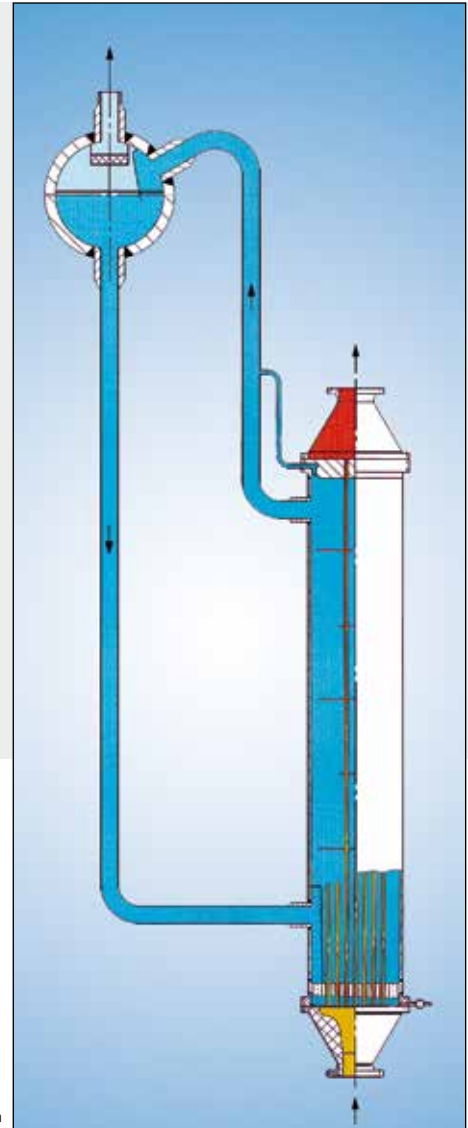


Fig. 1: Quench System

Fig. 2: 3D simulation of Quench System



Compact Quench Systems ready for shipment



“TUNNELFLOW” TRANSFER LINE EXCHANGER - GASINLET TUBESHEET DESIGN

A design is necessary which combines two requirements:

1. The high pressure on waterside (up to 150 bar g) calls for a thick tubesheet.
2. The high gasinlet temperature and the high gasside heat transfer coefficient calls for a thin tubesheet in order to keep its metal temperature low.

It is obvious that a thick tubesheet is impracticable because metal temperature of the tubesheet would be too high due to heat transport from the gas into the tubesheet. The cooling effect of the water on the waterside face of the tubesheet is too low to reach sufficient cooling of such thick tubesheet.

It has to be recognized that neither ferrules nor refractory can be used to protect the inlet tubesheet and the tube ends as the cracked gas would cause coke formation in the small voids of the refractory and behind ferrules. The coke tends to grow and would destroy refractory and ferrules.

A solution with thin tubesheets, which are anchored by the bundle tubes would allow sufficient cooling of the tubesheet but has considerable disadvantages: Tubesheets deflect in the transition area between tube bundle and shell. Failure can be expected there after a certain number of cycles. Tubes act as stays and elongate due to pressure load on the tubesheet and due to differential thermal expansion between shell and tubes. Consequently the stress concentration in the tube to tubesheet welding is fairly high and can also lead to failure.

The principle of a design - which was developed by BORSIG in 1965 - and which perfectly combines the two requirements regarding pressure and temperature, can be seen in Fig. 3. A thin tubesheet (1) of only approx. 10-15 mm thickness is reinforced by a thick forged anchoring plate (2). The waterside pressure load on the thin tubesheet is transferred via anchoring ribs (3) to the thick forged anchoring plate (2) and from there to the cooler shell (4). The anchoring ribs (3) are machined out of the thin tubesheet (1) and the thick forged anchoring plate (2) thereby forming tunnels: “Tunnelflow” TLE.

The advantages are obvious:

- Since the inlet tubesheet (1) is thin, very efficient cooling and low metal temperature is obtained.
- The gas inlet tubesheet (1) does not deflect and remains flat under all conditions because it is reinforced and held in position by the anchoring plate via the anchoring ribs (3).
- Tubes (5) do not act as anchors, therefore the stress in the tube to tubesheet welding is low (differential thermal elongation between tubes and shell is of almost same magnitude as the shell elongation due to waterside pressure on the tubesheets).
- Low metal temperature of inlet tubesheet (1) and tube ends allows the use of ferritic steel with 0,5% Mo which does not require any post weld heat treatment.
- No pressure limitation on waterside.

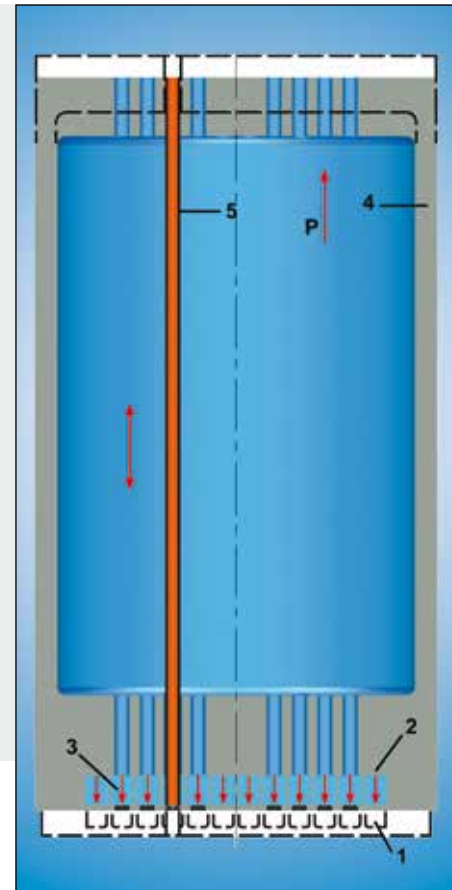


Fig. 3: Design principle

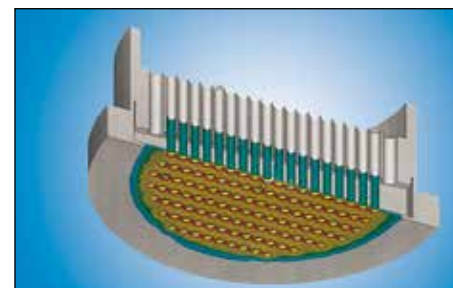


Fig. 4: Temperature acting on the “Tunnelflow” gasinlet tubesheet

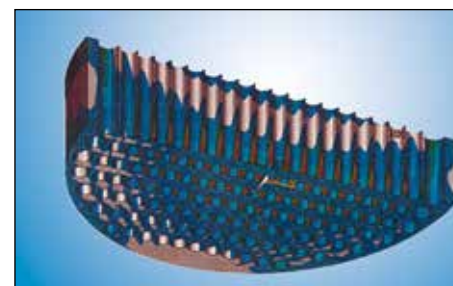


Fig. 5: Stresses acting on the “Tunnelflow” gasinlet tubesheet

“TUNNELFLOW” TRANSFER LINE EXCHANGER - WATERFLOW AT GASINLET TUBESHEET

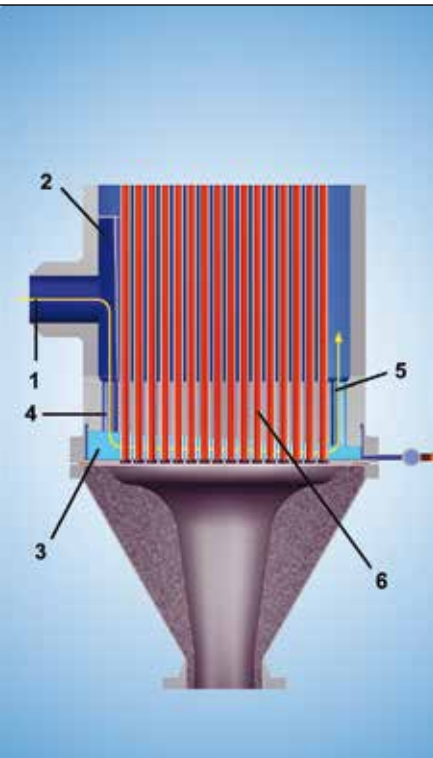


Fig. 6: "Tunnelflow" TLE, waterflow principle

With vertically arranged coolers, where the inlet tubesheet is the lowest point of the water system, high water velocity across the gas inlet tubesheet is important in order to avoid problems by settling of solid particles. Small solid particles quite often enter into the water, especially during commissioning. In addition, the waterside surfaces produce Fe_3O_4 (magnetite). The magnetite layer protects the steel and constantly renews itself slowly from the metal surface at operation temperature, hereby releasing a small amount of magnetite particles into the water.

The BORSIG "Tunnelflow" design (Fig. 6, 7 and 8) provides a guided water flow across the gasinlet tubesheet.

From the downcomer (1) water flows into an internal water chamber (2). In the water chamber (2) the water flows down-ward and enters the flow tunnel (3) through inlet holes (4). Each tunnel is furnished with one inlet hole. In the tunnel the water flows to the opposite side with high velocity, hereby avoiding any settling of solids on the thin tubesheet. On the opposite side, water flows upward through the outlet holes (5) to the main shell space. A certain portion of the water enters the main shell space via annular gaps (6) around the tubes in the thick anchoring plate. Since the design ensures high water velocity across the tubesheet, solids consequently cannot settle, overheating and hot water corrosion cannot occur.



Assembly of "Tunnelflow" tubesheet

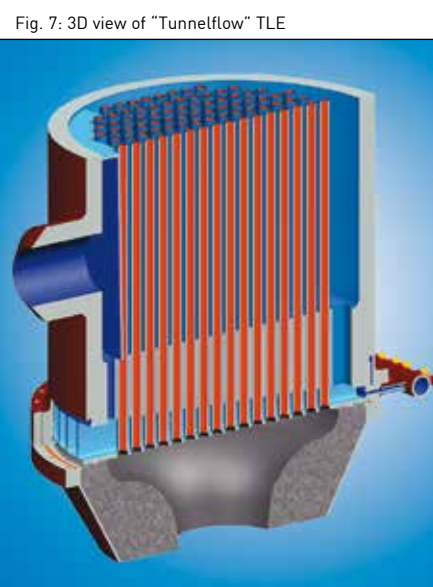


Fig. 7: 3D view of "Tunnelflow" TLE

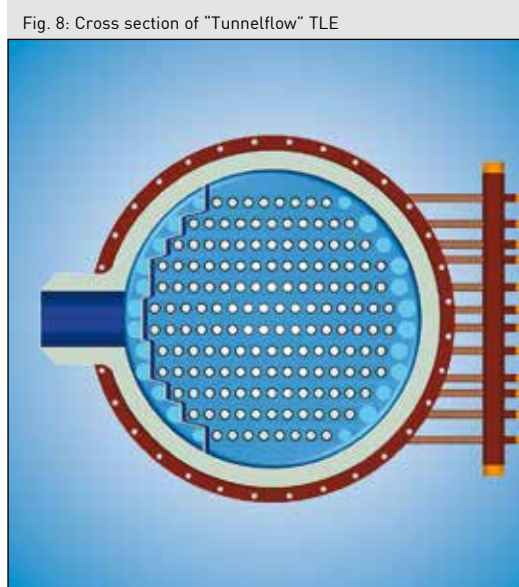


Fig. 8: Cross section of "Tunnelflow" TLE

Thin tubesheet/thick tubesheet



“TUNNELFLOW” TRANSFER LINE EXCHANGER - MANUFACTURE OF GASINLET AND GASOUTLET TUBESHEET



Tube to tubesheet welding at gasinlet

The tubes are automatically welded to the gasinlet tubesheet. This full penetration welding is computer controlled using an orbital program. The root pass of the tube to tubesheet weld is obtained by fusing the edge of the tube to the edge of the tube-sheet with filling wire, protected by shield gas. After that multiweld layers are applied.

There is no gap between tube and tubesheet, therefore no crevice corrosion on the waterside can occur.

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

Anchoring rib to gasinlet tubesheet welding (Fig. 10)

The anchoring ribs are machined out of two solid forgings. The short ribs of the thin gasinlet tubesheet are weld connected to the longer ribs of the thick anchoring plate by means of full penetration automatic TIG welding.

Tube to tubesheet welding at gasoutlet

A gasoutlet tubesheet according to Fig. 11 is used. The tubes are expanded inside the hole and fillet welded with a multi layer seam. 0,5 Mo material is used which does not require any postweld heat treatment. A vent bore is provided for in the upper tubesheet and is connected to the nearest riser. This prevents any steam accumulation.



Fig. 9:
Tube to
tubesheet
weld

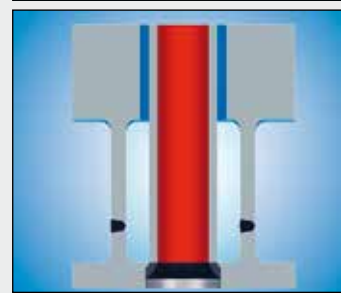


Fig. 10:
Anchoring rib
to gasinlet
tubesheet weld



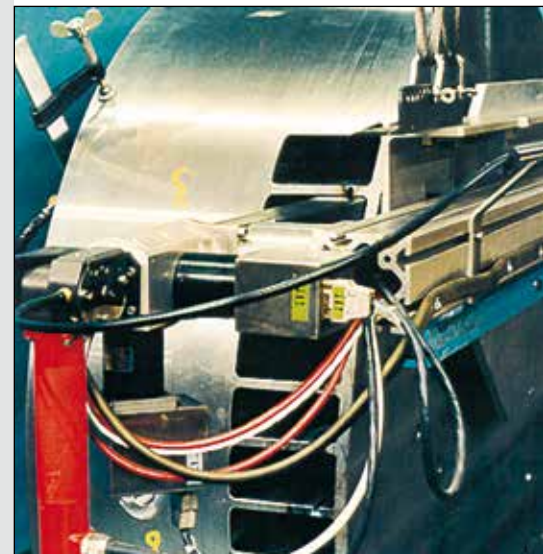
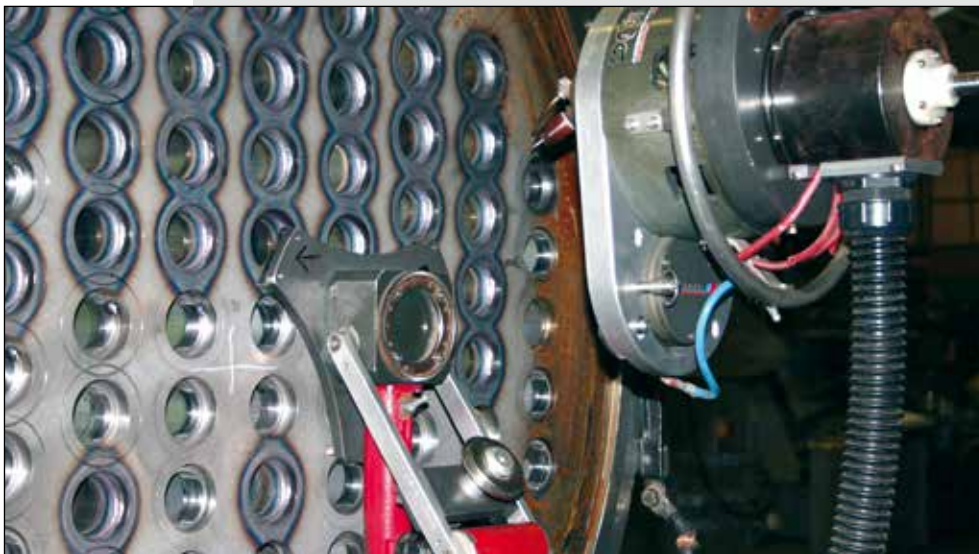
Fig. 11:
Gasoutlet
tubesheet

Specimen of tube to
tubesheet weld



Fully automatic
welding of thin/thick
tubesheets

Fully automatic tube to tubesheet welding



“TUNNELFLOW” TRANSFER LINE EXCHANGER - OTHER DESIGN FEATURES

Gasinlet Channel

The inlet channel design must ensure uniform gas flow to all tubes, minimum residence time within the channel and low pressure drop. The gasinlet channel design as shown in Fig. 12 has been optimized by computational fluid dynamics (CFD) and fulfills all these requirements. Neither any anchors nor metal liners are required as the high dense refractory contents stainless steel needles, thereby providing reinforcement and high abrasion resistance.

Hard coke particles in the gas flow may cause erosion of the gasinlet tubesheet and tube inlets. BORSIG Process Heat Exchanger GmbH has developed a protection shield which is anchored in the refractory of the channel.

Steam Drum

All required nozzles - including nozzles for risers and downcomers - are provided for. Access to the drum inside is possible through a hinged, oval manhole. The drum internals are designed based on BORSIG's more than 40 years of experience. Thus the feedwater nozzle is designed as “thermo-nozzle” and provided with an internal feedwater distribution system, the downcomer nozzles are provided with Vortex breakers.

As steam/water separator we use a demister package.

Interconnection Piping

The design of the vertical quench system is such that only one downcomer and one riser line is required. This considerably minimizes the erection work. The pipings are workshop prefabricated to the furthest possible extent. Only some circumferential weldings are necessary in the field. Each line is provided with spring hangers and pipe clamps if necessary. A piping stress analysis is done to determine the forces and moments acting to the steel structure in which the TLE and the drum are installed.



Shipped steam drums

Manufacturing of steam drum



Erosion protection shield



“TUNNELFLOW” TRANSFER LINE EXCHANGER - HIGHLIGHTS



“Tunnelflow” TLEs ready for shipment

BORSIG Process Heat Exchanger GmbH has more than 40 years experience in the area of quench coolers.

- The gas inlet tubesheet is thin and reinforced by an anchoring plate. Therefore metal temperature is kept low.
- Due to high water velocity across the gasinlet tubesheet solids cannot settle. Hot water corrosion by overheating cannot occur.
- No pressure limitation on water/steamside.
- Uniform distribution of gas to inlet tubesheet.
- Only one riser and one downcomer line required.
- No postweld heat treatment required for tubesheet weldings.
- Easy maintenance.

By purchasing the complete quench system from BORSIG the contractor’s manhour expenditure is reduced. BORSIG Process Heat Exchanger GmbH has provided about 2500 Transfer Line Exchangers of this type since 1965 to all parts of the world. All engineering companies and contractors which are active in the field of ethylene plants have already installed BORSIG “Tunnelflow” Transfer Line Exchangers.

Fig 12: Gasinlet channel design



Steam drum internals



“TUNNELFLOW” TRANSFER LINE EXCHANGER - ENGINEERING AND AFTER SALES SERVICE

The stresses and temperatures acting on the “Tunnelflow” gasinlet tubesheet assembly are analysed by using the finite element method. 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).

Calculations of pressure vessels and heat exchangers are performed according to all worldwide established codes like AD, TRD, ASME, BS, Raccolta VSR, Codap, Stoomweezen, IBR, JS, Australian Standard and others. Critical components are subject to additional strength calculations by using the finite element method. Flexibility, routing, foundation loads and forces of interconnecting piping are calculated by computer programs.

BORSIG Process Heat Exchanger GmbH supplies also the service of complete replacement jobs. After locating the TLE with its supports to the furnace structure, the coil outlet can be connected to the TLE gasinlet channel. After setting up the steam drum the interconnecting piping between TLE and steam drum can be installed.

The interconnecting piping is bended and prefabricated to the furthest possible extent requiring only a few circumferential welds during erection.

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. The waterside of the whole quench system including upstream units have to be cleaned carefully before start-up to guarantee the build-up of a sound and homogeneous protective layer of magnetite on all waterside surfaces.

After hydrostatic tests, the waterside of the TLE will be pressurized with nitrogen for protection during transport and erection.

Shipment via BORSIG harbour



Road transport





Transfer Line Exchangers at the works area

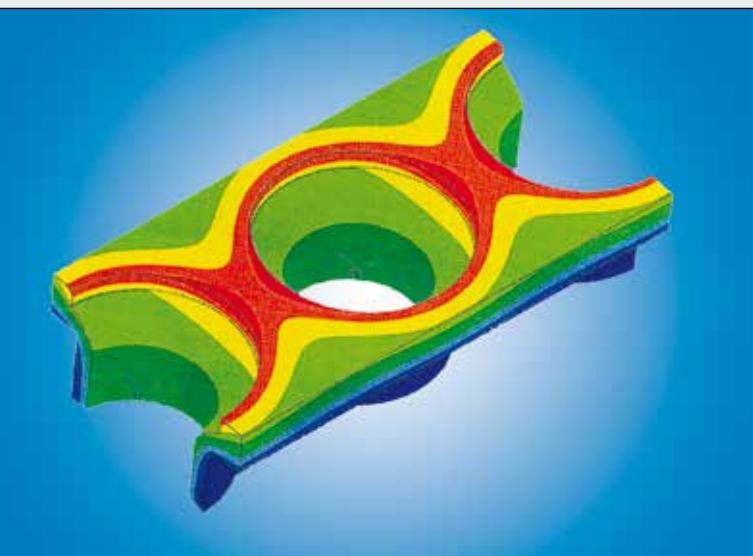


Fig. 13: Temperature distribution on "Tunnelflow" gasinlet tubesheet

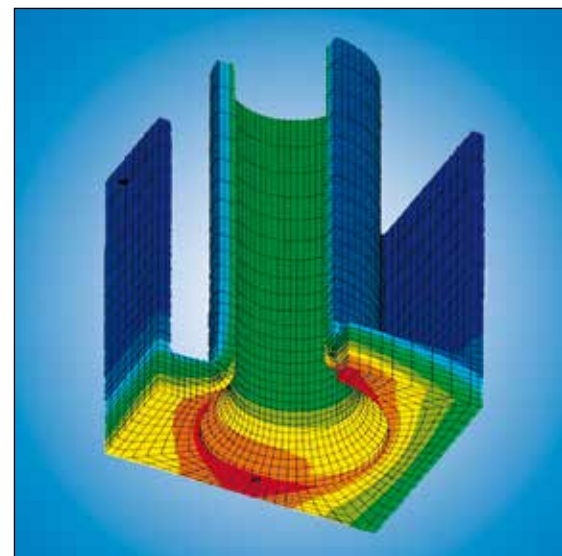


Fig. 14: Stresses acting on the "Tunnelflow" gasinlet tubesheet



“LINEAR” TRANSFER LINE EXCHANGER



Naphtha Cracking
Furnaces



Double pipe elements in the workshop

“LINEAR” TRANSFER LINE EXCHANGER - BASIC DESIGN CONCEPT

The patented BORSIG linear quencher (BLQ) consists of a number of linearly arranged double pipe elements of which each is directly coupled to one of the furnace radiant coil outlets.

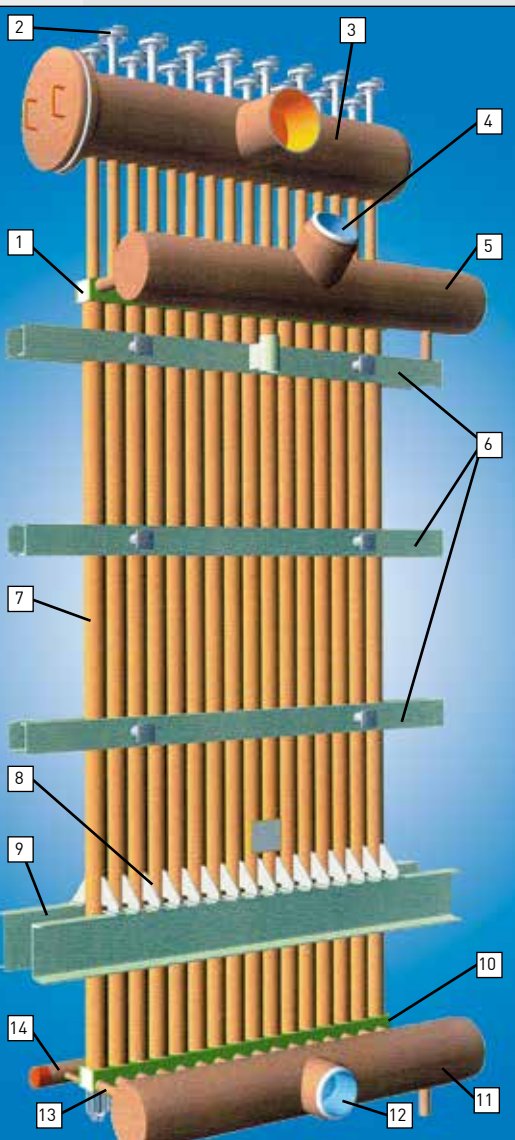
The process effluent from each single radiant coil is quenched individually in its own double pipe element.

A common downcomer header distributes uniformly the circulating boiler water coming from the steam drum to each of the “Turboflow” inlet chambers. A riser header is collecting the steam/water mixture from the upper outlet chambers.

The picture below shows a typical BLQ arrangement. Other arrangements are possible, even the twin leg concept if the available place in the furnace structure is limited.



BLQ ready for shipment



Typical BLQ arrangement:

1. Outlet chambers
2. Inspection/Clean out nozzles for hydrojetting
3. Gas collection header
4. Riser nozzle
5. Riser header
6. Guides
7. Double pipes
8. Supporting brackets
9. Supporting frame
10. “Turboflow” inlet chambers
11. Downcomer header
12. Downcomer nozzle
13. Gasinlet nozzle
14. Blow down header

BLQ in the furnace structure



“LINEAR” TRANSFER LINE EXCHANGER - ARRANGEMENT AND DESIGN



Computer simulation of two naphtha cracking furnaces

A flexibility analysis for the interconnecting piping system between the steam drum and BLQ is performed for each specific project.

Arrangement

The BLQ is a versatile exchanger design with a wide range of optional orientations which fulfills the specific requirements of all engineering contractors active in the design of ethylene furnaces.

The most common arrangements are the single leg and the twin leg concept.

Design

The BLQ is a modularized design which permits a very narrow spacing of the double pipes and allows tube configurations which perfectly meet the individual coil and furnace layout requirements. The pipes can be arranged linearly or with offset arrangement if required. The very narrow inline pipe spacing is possible due to individual manufacture of the double pipe elements. Performing the weld of the outer pipe to the water chamber is not impaired by a close location of the neighbouring pipe.

After the pipes are individually manufactured and nondestructively tested, they are assembled to a register of double pipes with all necessary headers, nozzles, brackets and supports. The pipe spacing can be as close as the O.D. of the outer pipe, if required. The “Turboflow” chamber design allows the number of coils in a single radiant coil module with the same narrow spacing to be practically unlimited.

The BLQ can be designed and manufactured according to all international recognized codes and standards such as German AD-Merkblätter, ASME etc.

BLQ during shipment



Secondary Transfer Line Exchanger / Steam Drum Unit



“LINEAR” TRANSFER LINE EXCHANGER - DESIGN FEATURES

Individual “Turboflow” chamber

The BORSIG “Turboflow” concept uses a tangentially arranged water inlet nozzle at chamber which ensures a rotating water flow (turboflow) around the process gas pipe.

This concept was developed from our unique conventional “Tunnelflow” TLE which accelerates the boiler water across the hot tubesheet. Applying this concept to the double pipe BLQ ensures that any potential solid deposition is eliminated at the hot inlet of the exchanger.

The independence of each “Turboflow” chamber results in a singular water flow path that is unaffected by the adjacent pipe and results in a lower overall annular waterside pressure drop compared with the traditional oval header design.

Elimination of dirt pockets

The water inlet nozzle is flushed to the bottom of the “Turboflow” chamber which eliminates any dead zones or dirt pockets that can lead to corrosion at the inlet of the BLQ.

Waterside dead zones are eliminated

The “Turboflow” concept with individual and independent water chambers eliminates possible dead zones in the lower and upper water headers between adjacent pipes on the waterside.

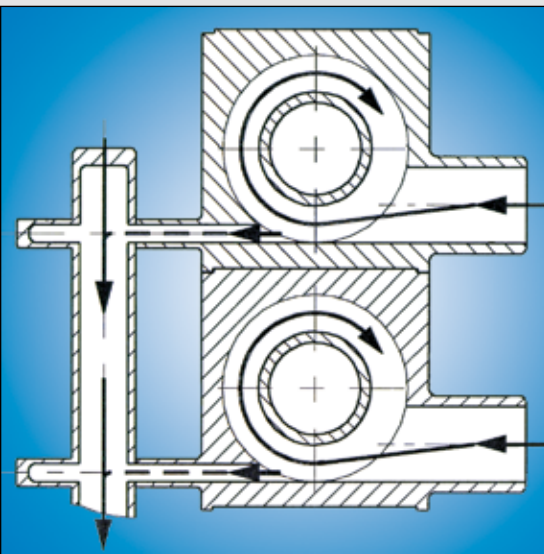
Gas inlet head

On the process side each double pipe is directly connected to a radiant coil outlet by a refractory lined gas inlet head guiding the cracked gas from the coil to the inner pipe. No steam purge is required.

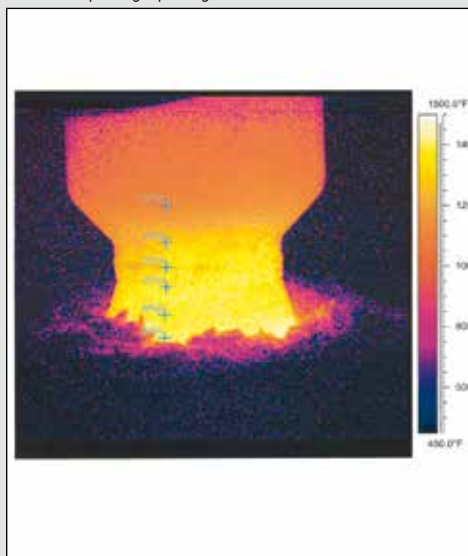
The BORSIG designed BLQ uses a patented and well proven proprietary three refractory design with metal sealing ring seal. This design is superior to the traditional single layer design with regard to temperature and stress distribution because the thermal gradient along the gas inlet head is reduced more uniformly.

The metal sealing ring seal provides additional protection of the refractory from hydrocarbon infiltration.

“Turboflow” chambers with optional blowdown/drain pipe



Infrared photograph of gas inlet head



Individual ejection nozzles with common header

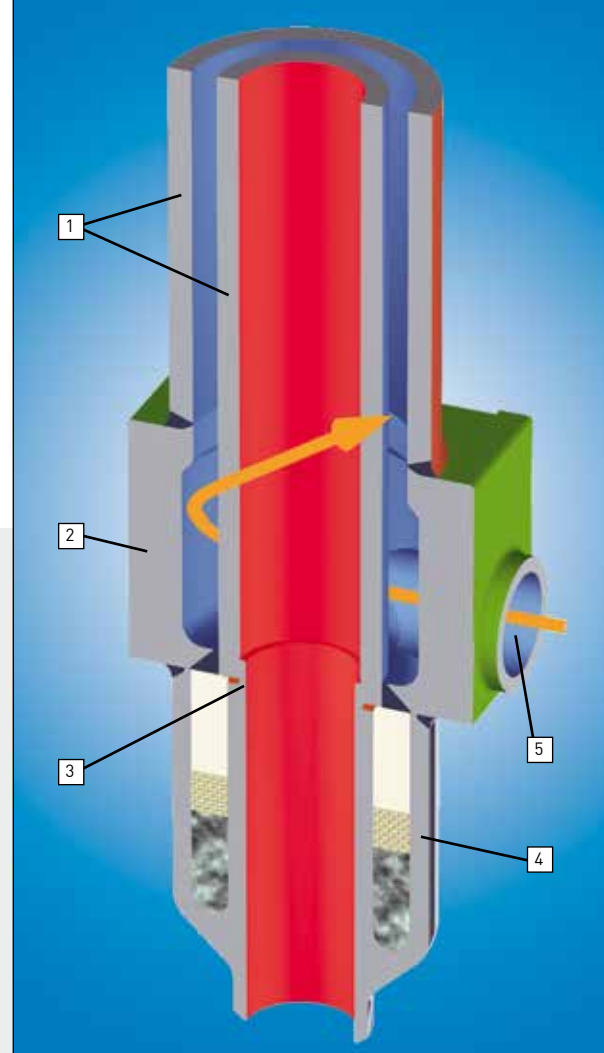
Unlike comparable designs that typically only have one drain for a group of waterside tubes, each "Turboflow" chamber has its own solid ejection nozzle located at the lowest point of the quench system, thus any debris can easily be ejected during start-up or operation and all cleaning fluid can be removed. It can also be used as drain and to inspect the "Turboflow" chamber during routine maintenance. The individual ejection nozzles can also be easily piped to a common location for blowdown purposes.

Alignment

For the alignment of the individual "Turboflow" chambers and for guidance in the transverse direction male/female recesses are provided for. This ensures a ridged connection of the "Turboflow" chambers without requiring welding.

Manufacturing

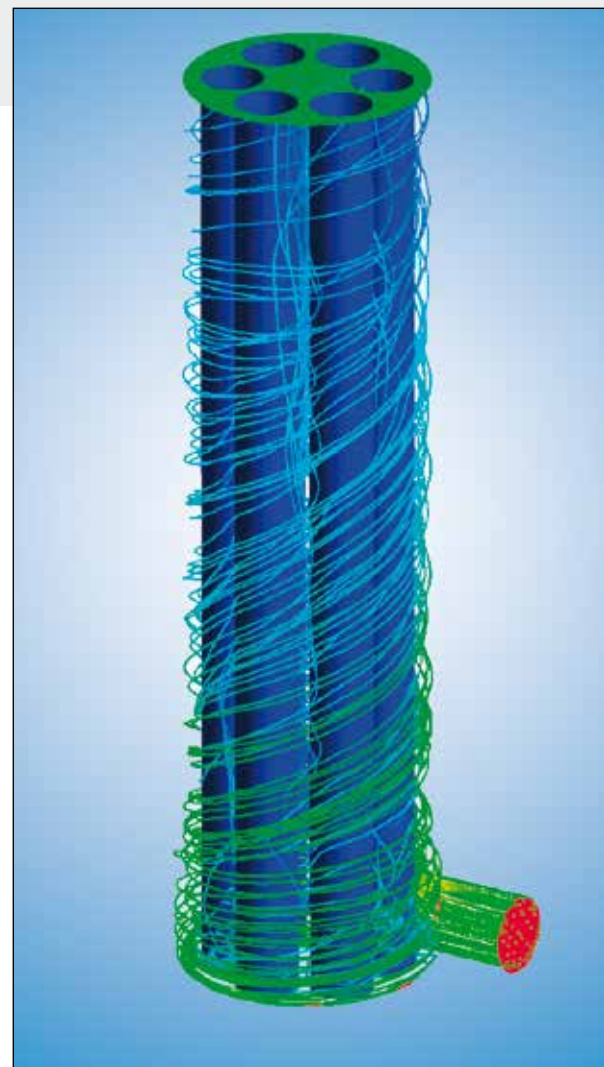
The water chambers are manufactured from a solid block of steel in which the circular "Turboflow" chamber is machined in.



The BORSIG "Turboflow" concept

- 1. Double pipe
- 2. "Turboflow" chamber
- 3. Metal sealing ring
- 4. Gas inlet head
- 5. Water inlet nozzle

CFD analysis of waterflow in BLQ "Turboflow" chambers



Gas inlet heads with BfW supply header



“LINEAR” TRANSFER LINE EXCHANGER - SIZES AND DIMENSIONS

Inner Pipe

The BLQ pipe size range is practically unlimited, however, the range of sizes chosen by furnace designers is typically in the range of 45 - 150 mm inside diameter. For liquid cracking, ethylene production is much more strongly favoured by a low overall system pressure drop. To achieve this, the furnace designer will often choose many small diameter radiant coils with short residence time and low pressure drop but he was previously limited in the choice of exchanger configuration to match this coil design.

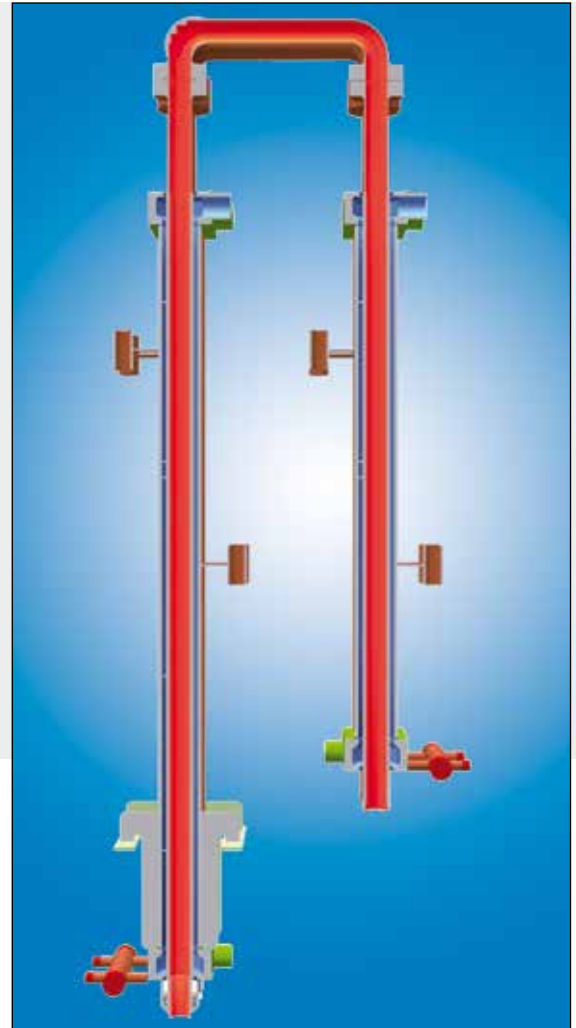
The BLQ improves the quench exchanger choice for the furnace designer by allowing each radiant coil to have its own individual quench exchanger even if the coils are on very close pitch. With inner pipe internal diameters that are similar to the internal radiant coil dimensions, the BLQ can often perform the heat recovery duty required in a single exchanger rather than two or more exchangers found in some furnace designs. For gas cracking, many furnace designers select larger diameter coils with larger internal diameter quench exchanger pipes. The BLQ can also meet this requirement using a variety of orientations such as roof, side or bottom mounted locations. The BLQ can be designed with a single primary leg or primary and secondary leg combined into one unit for small or large diameter coils depending on feedstock and furnace configuration.

Length

The length of the exchanger is limited to the location of the steam drum in the furnace structure. The centerline of the steam drum must be above the top water chamber for the thermosyphon system to operate adequately. Current designs have been built at approximately 20 m (approx. 60 feet) long although future designs could exceed this length.

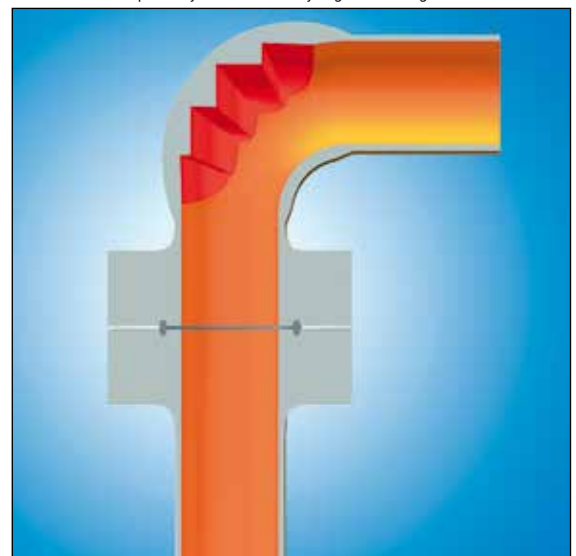
Erosion resistant return bend

The erosion of fittings and bends caused by coke particles is well known. In case of U-type BLQ's (primary and secondary leg) we provide a stepped type bend located at the end of the primary leg. We can offer the conventional inverted U-bend design but for gas cracking we prefer to provide our stepped bend.

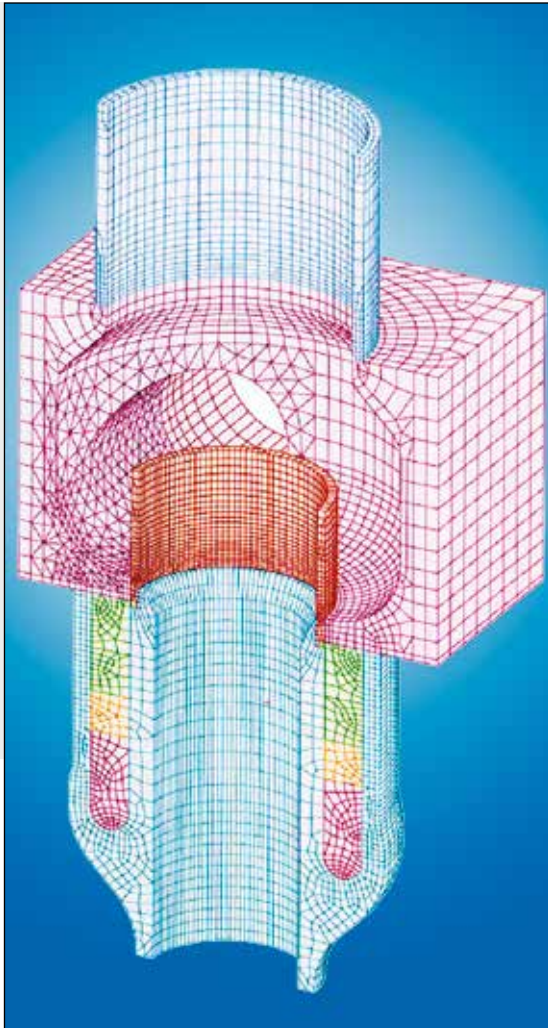


Twin leg BLQ for gas cracking

Connection of primary and secondary leg of twin leg BLQ



“LINEAR” TRANSFER LINE EXCHANGER - STRESS ANALYSIS



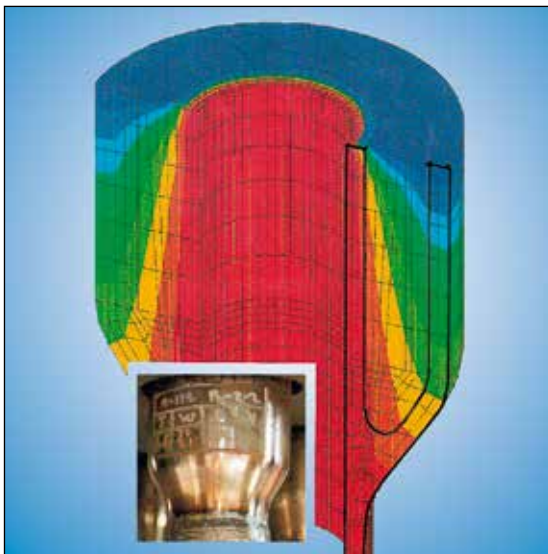
Gas inlet and water chamber model for FEA

A detailed structural analysis of the “Turboflow” chamber is performed with FEA. The wall thickness of the “Turboflow” chamber provides sufficient strength and a low stress level to satisfy the ASME VIII, DIV. 2, Appendix 4 requirements even with large diameter pipes.

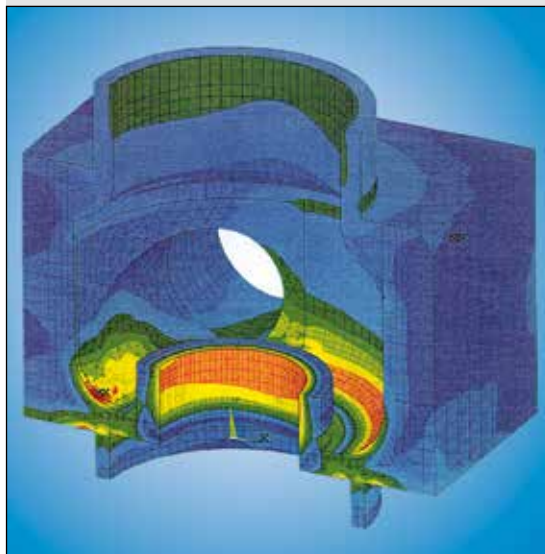


Modulized BLQ elements

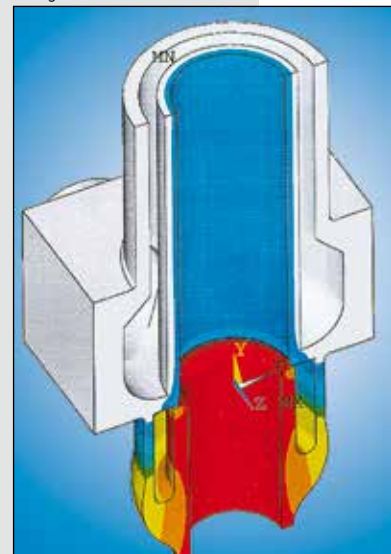
Gas inlet head



“Turboflow” chamber contour showing stress intensity



Temperature distribution at gas inlet section



“LINEAR” TRANSFER LINE EXCHANGER - HIGHLIGHTS

BORSIG Process Heat Exchanger GmbH has more than 40 years experience in the area of quench coolers.

- Closely and directly coupled to each radiant coil outlet.
- Eliminates wye, tri or tetra fittings in the cracking furnace.
- No hot tubesheet: no fouling, no erosion.
- Low volume of BLQ gasside: low residence time.
- Low overall pressure drop.
- No off-line decoking but online decoking.
- Upflow or downflow arrangement.
- Single leg or twin leg design.
- Compact and modular design.
- Individual exchangers.
- No restriction in quench pipe diameter.
- Three refractory gas inlet heads: no steam purge required.
- “Turboflow” chamber design.
- One common water and one common steam header per BLQ module.
- Ease of maintenance.

By purchasing the complete quench system from BORSIG the contractor’s manhour expenditure is reduced. BORSIG Process Heat Exchanger GmbH provides the complete system comprising the design of the BLQ, riser and downcomer pipework and steam drum, i.e. the complete quench system.

BORSIG Process Heat Exchanger GmbH has provided about 4,800 Transfer Line Exchangers of this type with total more than 20,700 double pipes since 1990 to all parts of the world. All engineering companies and contractors which are active in the field of ethylene plants have already installed BORSIG linear quenchers.

BLQs during shipment



Steam drum ready for shipment





BLQ during installation

BLQs at our works

Secondary Transfer Line Exchanger / Steam drum Unit



“LINEAR” TRANSFER LINE EXCHANGER - ENGINEERING AND AFTER SALES SERVICE

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). Calculations of pressure vessels and heat exchangers are performed according to all worldwide established codes like AD, TRD, ASME, BS, Raccolta VSR, Codap, Stoomweezen, GOST R, IBR, JS, Australian Standard and others.

Critical components are subject to additional strength calculations by using the finite element analysis. Flexibility, rooting, foundation loads and forces and interconnecting piping are calculated by computer programs.

Maintenance

The modular construction of the BLQ eases repair in case a plant upset damages a BLQ. The damaged single element can easily be removed and can be replaced by a spare. After cutting the process and waterside connections the double pipe element can be lifted upwards and can then be removed leaving the remaining double pipes in the furnace structure.

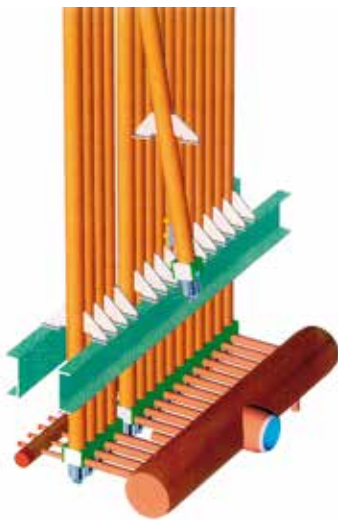
Transportation to site

Even the twin leg design BLQ will be shipped as one compact module completely workshop assembled including the downcomer, riser and gas collection header. After hydrostatic test the waterside of the BLQ will be pressurized with nitrogen for protection during transport and erection. The BLQ will be shipped mounted on a wooden skid having the necessary hoisting lugs for use during transport. One removable lifting device will be delivered for convenient transport and erection.

Cutting process /
waterside connections
lifting upwards



Removing of BLQ
double pipe out of
the module



Upper end of BLQ with gas collection head and riser header



Erection

Using two cranes and the lifting device delivered with the BLQs, the module can easily be removed from its transport skid and can be brought into vertical position.

After locating the BLQ with its integral supports to the furnace structure, the coil outlets can be welded to the BLQ gas inlet heads and after setting up the steam drum the interconnecting piping between BLQ and steam drum can be installed. The interconnecting pipings are bent and prefabricated to the furthest possible extent requiring only a few circumferential welds during erection. Spring hangers, if necessary, are included in the scope of supply.

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. The waterside of the whole quench system including upstream units have to be cleaned carefully before start-up to guarantee the build up of a sound and homogeneous protective layer of magnetite on all waterside surfaces.

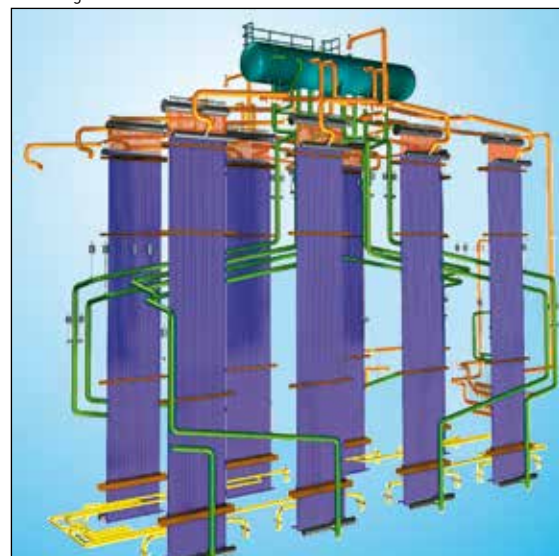


Installed BLQs

Installation of BLQ



BLQ system with 8 straight upflow modules, serving one common steam drum



MANUFACTURING AND QUALITY ASSURANCE FOR TRANSFER LINE EXCHANGERS

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 surveils adherence to national and international specifications, statutory and contract provisions as well as the directives, standards and regulations stipulated by BORSIG.

BORSIG Process Heat Exchanger certification comprise

- 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.

In 2003 BORSIG Process Heat Exchanger GmbH has introduced the Integrally Management System (IMS) comprising of quality, works safety and environmental management systems.

Fabrication of BLQ



Penetration testing of TLE





Fabrication of BLQ

Testing of BLQ



Testing of BLQ



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