

BHDT High Pressure Products

for a Safe and Reliable Urea Industry

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1. Introduction BHDT GmbH

BHDT (former BÖHLER Hochdrucktechnik) is a technologically qualified supplier and manufacturer of high pressure equipment and high pressure components for the chemical and petrochemical industry, as well as pumps generating pressures (up to 10,000 bar) for liquid media.

We manufacture our products in co-operation with licensors of chemical processes using high-precision computer-controlled processing machinery and taking customer demands into account at the highest level of technological standards. Thanks to decades of experience, superior materials and quality-assured order handling, we have gained an excellent position on the global market.



Picture 1: BHDT Headquarters in Kapfenberg, Austria



More than five decades of experience have made BHDT well known all over the world as a reliable manufacturer of high pressure valves (angle, globe, check, safety, analyzer, sample and control valves), all kind of fittings (tees, elbows, reducer, nipple, threaded flange, weld neck flange, weldolet, etc.) and prefabricated high pressure pipeline isometrics (spools) especially for Urea and Ammonia plants.

Special know-how in the field of material science (Austenitic stainless steel 316L Urea Grade and 25Cr-22Ni-2Mo, Duplex and Superduplex including Safurex®) for manufacturing of Fertilizer products in cooperation with all major licensors such as Stamicarbon, Saipem, TEC, KBR and Urea Casale assures high quality products.

Valves and fittings are made exclusively of forged material. The exact knowledge of process technologies guarantees optimum function and long service life of our products. All connections can be produced to conform to all international standards including ANSI B 16.5, 1500#-2500#, DIN, IG, as well as customer standards. We also offer all kinds of actuators (gear, electric, hydraulic or pneumatic).

BHDT is not only producer of top-quality high pressure components but is also a supplier of complete customized high pressure systems for the Petrochemical Industry, and contractor for large industrial plants. BHDT has an excellent expertise because of decades of experience on the world market. Complex customer requirements are executed in the framework of an efficient, objective oriented project management.

BHDT is expanding continuously its facilities and services: after the opening of the new Deep Hole Drilling shop in 1999 and expanding this shop in 2006, recently BHDT opened another new shop close to their headquarters of which a picture is shown below.



Picture 2: BHDT 3rd workshop close to its headquarters

Further BHDT is expanding into new business areas like BHDT Oil & Energy and with the BHDT Service company BHDT will further intensify services to the end-users.

2. BHDT Service: Best Quality and Maximum Reliability

The trends in project development of large capital projects like new ammonia/urea complexes show that the overall responsibility is shifting from contractors to operating companies. Also local engineering and local construction companies are becoming stronger, more experienced and more involved in these projects. BHDT has decided to intensify its services business in order to adapt to these trends and deliver more added value to contractors and operating companies.

BHDT Service's mission is to:

- Offer Full Life Cycle support for all High Pressure Piping systems
- Learn & Improve via strategic partnerships with operating companies
- Become the One Stop Solution provider for all HP piping issues
- Offer Best Quality and Maximum Reliability

The activities of BHDT Service include all activities related to High Pressure piping systems in a urea plant; from Engineering, Installation services, Corrosion Inspections, Troubleshooting, Emergency supply/repair, Spare Parts Management up to Training Programs.

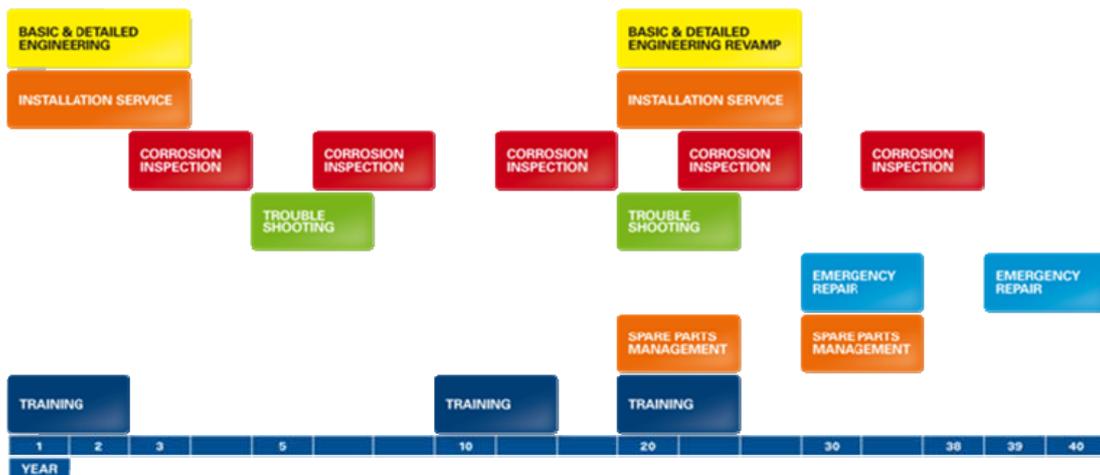


Figure 1: BHDT Service during the lifetime of a urea plant

The figure above shows that during the life time of a urea plant each of these services can and will become necessary. BHDT Service offers all these services; BHDT Service is the One Stop Solution provider for all your High Pressure Piping issues.

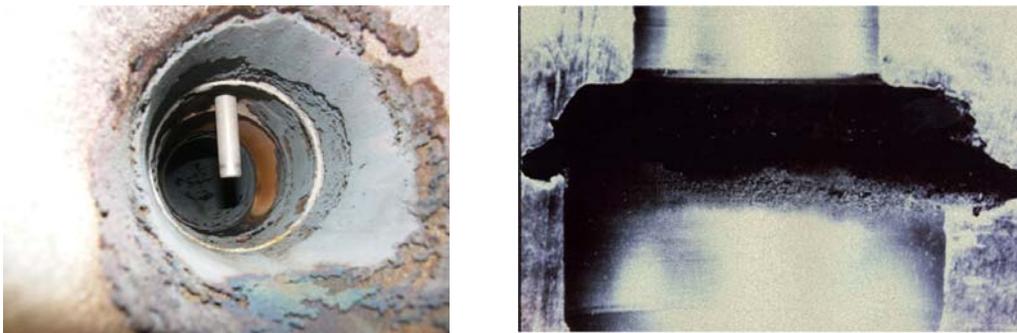


Picture 3a/b/c: Different BHDt Service activities such as installation services (left and middle) and corrosion inspection services (right). Urea Know-How

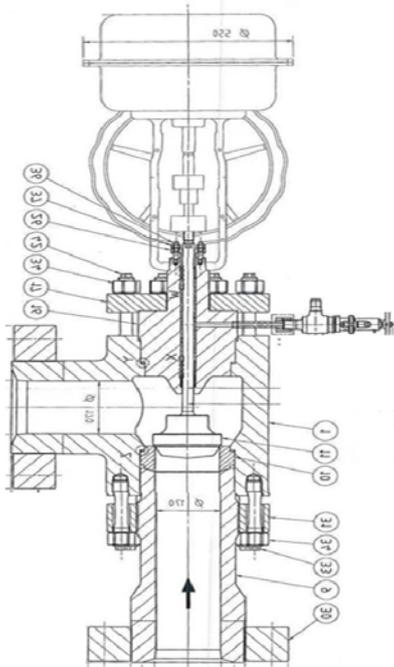
BHDt's strength is delivering Best Quality products together with a long term experience with applications in urea plants. The operating conditions are tough in a urea plant especially in the High Pressure Synthesis section, not only due to the high pressures (typically 140-240 bars) and high temperatures (typically up to 220 °C) but even more due to the aggressive corrosive environment caused by carbamate.

Each High Pressure Control Valve in the urea synthesis section requires its specific attention points: Some have a large pressure drop due to which in some crystallization can occur, others control a large flow while the available pressure drop is very small. Almost all control a stream where the corrosive carbamate is present and where special precautions are needed to realize a reliable operation. BHDt has the experience and urea know how available to offer you that.

Furthermore several different corrosion phenomena like crevice corrosion, condensation corrosion, erosion corrosion and active corrosion are important to take into account in the design of high pressure valves and fittings. The pictures below show some examples of typical corrosion problems in urea plants (here condensation corrosion and erosion corrosion).



Picture 4a/b: Examples of typical corrosion problems in urea plants: Condensation Corrosion (left) and Erosion Corrosion (right)



The main urea licensors are Stamicarbon, Saipem, TEC and Urea Casale and BHDT has abundant experience with these companies, sometimes directly, sometimes via a Contractor or End-user.

BHDT is able to fabricate control valves according any requested specification or in accordance with special wishes or requirements.

On the other hand BHDT is also very well capable to advise which precautions are best for which valve application: you may think extra flush connections, heating facilities, erosion resistant materials or other design features.

The figure on the left shows a BHDT High Pressure Control Angle Valve with a flush connection.

Figure 2: BHDT High Pressure Control Angle Valve with extra flush connection

BHDT is one of the few qualified and approved High Pressure Piping manufacturers for Safurex[®] material, which is nowadays a standard feature of a Stamicarbon license. BHDT has also abundant experience with the traditional austenitic stainless steels and duplex materials.



Picture 5: BHDT High Pressure Control Valves

The picture below shows the Stamicarbon CO₂ stripping urea plant of Yara Canada in Belle Plain, Saskatchewan in Canada.



Picture 6: YARA Canada in Saskatchewan, Canada

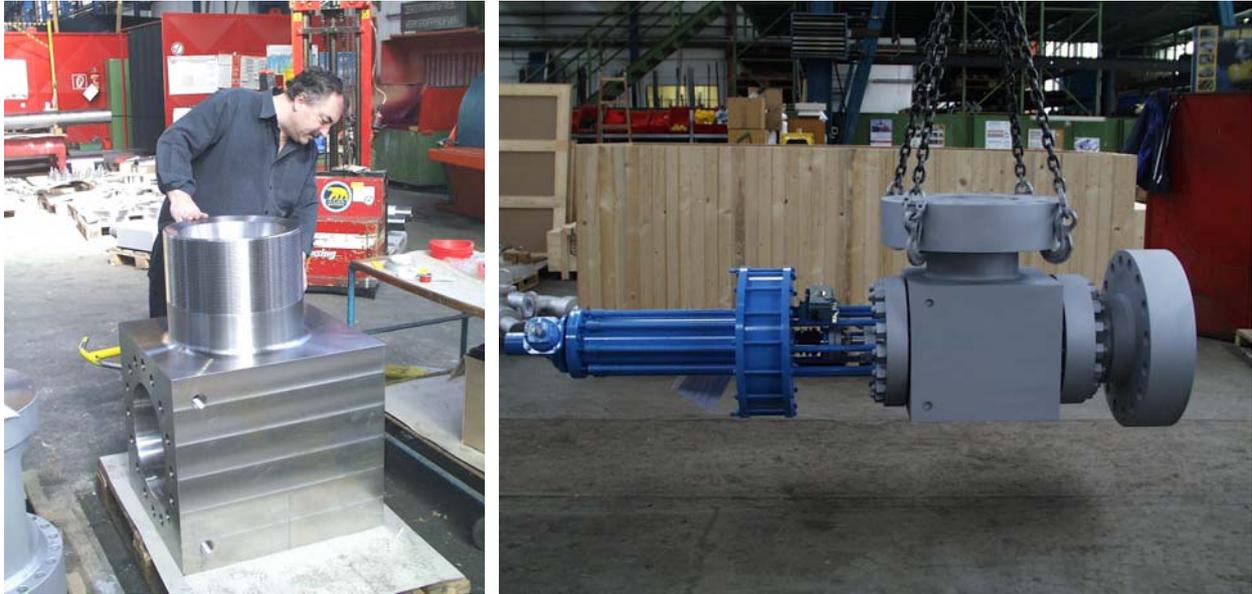
This Stamicarbon CO₂ stripping urea plant had an original design capacity of 2000 mtpd (metric tons per day) and was constructed in 1992 by Uhde, Germany. In 1997 the design capacity has been increased to 2850 mtpd and in September 2009 increased again to 3450 mtpd. For these two debottlenecking projects BHDT has supplied the High Pressure Piping materials and BHDT Service has provided the Installation Services of the new and modified High Pressure Piping parts. The Yara Canada urea plant was the first single line urea plant which produced more than one million metric tons of urea in one year.

The picture below shows the Safurex[®] High Pressure Control Valve of the ABF urea plant in Bintulu, Malaysia, which is a NS 10" pneumatic operated control valve.



Picture 7: A NS 10" Safurex[®] High Pressure Control Valve for the ABF urea plant in Malaysia

BHDT has also experience to manufacture NS 12", NS 14" and even NS 16" control valves as can be seen in the pictures below. This NS 16" control valve is the world largest control valve every built for a urea plant.



Picture 8A/B: The body (left) and complete NS 16" control valve for the Pardis Petrochemical Company in Iran made of 316L Urea Grade.

Safurex[®] is an innovative material of construction, which has been developed in a co-operation between Sandvik Materials Technology In Sweden and Stamicarbon. Stamicarbon latest design for grass root urea plants AVANCORE[®] is based on a complete Safurex[®] synthesis and makes use of all its advantages such as a zero oxygen requirement, which leads to an intrinsically safe design and improved performance figures. The figure below shows the high pressure synthesis section of Stamicarbon AVANCORE[®] process.

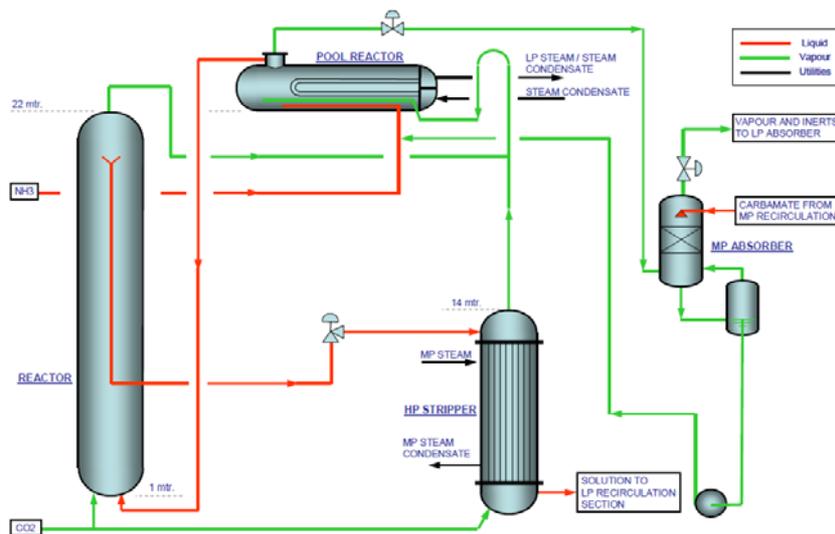
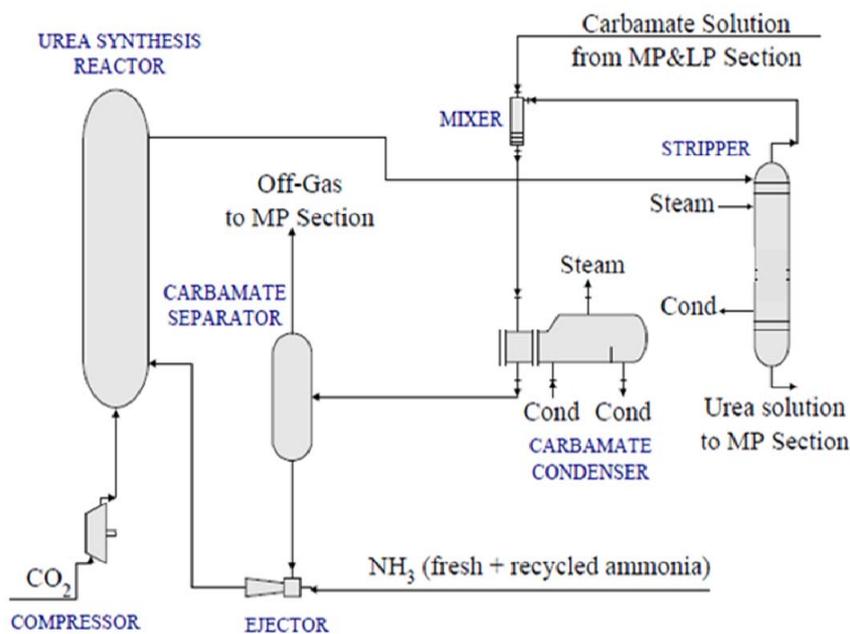


Figure 3: Stamicarbon's AVANCORE[®] Urea Process

In 2008 Saipem licensed out two 3500 mtpd urea lines to Algeria Oman Fertilizer Company in Arzew in Algeria. BHDT supplied for this giant complex the High Pressure Valves.



Picture 9: Algeria Oman Fertilizer Company in Algeria under construction, status January 2011.



The figure on the left shows the Saipem urea high pressure synthesis section. Unique in this scheme are the horizontal kettle type high pressure carbamate condenser and the high pressure ammonia or self stripping stripper, which are features already part of Saipem's urea technology for many decades.

Downstream of this high pressure urea synthesis a medium and low pressure recirculation section are present. In the medium pressure recirculation section a further separation between pure ammonia and carbamate is taking place.

Figure 4: Saipem urea synthesis section

In 2007 Toyo Engineering Corporation (TEC) licensed a 2200 mtpd ACES21™ urea plant in Venezuela. MAN Ferrostaal A.G. and VEC Ingenieria y Construction were jointly awarded a contract from the national petrochemical company Petroquimica de Venezuela, S.A. (PEQUIVEN) for the commercial scale project in Venezuela. The complex is located at the site of the Moron Petrochemical Complex in Moron. The figure below shows the flow scheme of the ACES21™ High Pressure synthesis section, which is TEC's latest innovative process scheme for urea plants. Unique in this scheme are the vertical lay-out of all high pressure equipment items including the pool condenser.

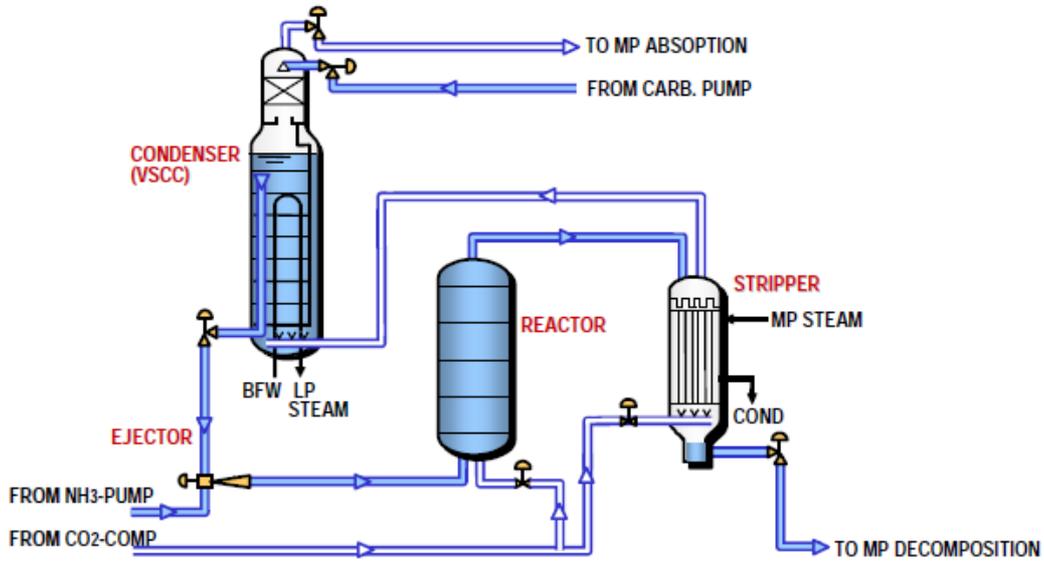


Figure 5: Flow scheme of the ACES21™ High Pressure synthesis section

The project is scheduled for completion in 2011 and will be the largest TEC ACES21™ urea plant currently in operation. BHDT has supplied the High Pressure Control Valves and Fittings for this plant. The scope included 15 SA182 F316L Mod. High Pressure Control Valves in sizes ranging from 1" to 10" and included commissioning spare parts. Please refer to the picture below.



Picture 10a/b/c/d: Three HP Control Valves for the TEC Moron project (status June 2010)

3. BHDT Base materials

BHDT's Best Quality starts with making use the right (high) quality base materials. BHDT applies the best base materials for its High Pressure Control Valves and Fittings such as Böhler A220 (316L Urea Grade), A405 (25-22-2) and of course Safurex®.

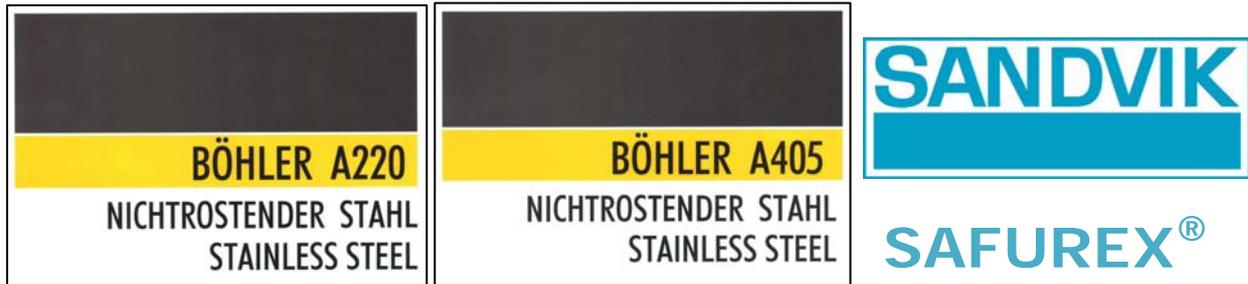
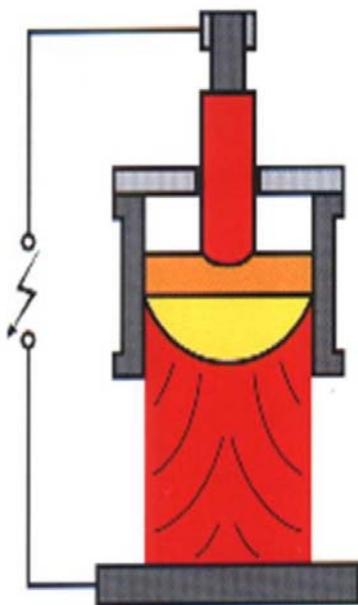


Figure 6: BHDT base materials



Böhler A220 and A405 materials are being produced by means of the sophisticated electro slag remelting process. The base material undergoes an additional purification step by remelting it from the bottom to the top of the ingot. The sulphur and other non-metallic components are collected at the top part and cut off in a final step. As a result the BHDT base materials for their High Pressure valves and fittings have a minimum sulphur content, minimum contents of non-metallic inclusions, isotropic properties and an optimally adjusted ingot weight.

The Böhler A220 and A405 materials quality fulfills all the quality requirements of all licensors. This means BHDT High Pressure Control Valves and Fittings are made of the Best Quality with the highest corrosion resistance properties assuring maximum lifetime and reliability.

Furthermore because of this standardization, BHDT is able to operate a flexible material stock which leads to lower costs and shorter delivery times. And these are direct benefits for our customers.

Figure 7: Electro slag remelting process

The Sandvik Safurex® material is developed in a co-operation of Sandvik Materials Technology and Stamicarbon and is successfully applied in numerous urea plants. Its mechanical properties are two to three times higher than the traditional austenitic stainless steels like 316L UG and 25-22-2 as can be seen in Table 1.

Table 1: Mechanical Properties of various base materials

Material	Yield	Tensile	Elongation
	Rp 0,2MPa 20 °C/225°C	Rm MPa 20 °C/225°C	A5, %min 20°C
Safurex®	650/465	800/717	25
316L Urea Grade	270/195	580/495	30
25-22-2	190/135	490/412	40

Remark: The values mentioned are the guaranteed minimum values

Because of its higher mechanical properties a significant smaller wall thickness can be applied in the high pressure urea synthesis section. Please refer to the table below.

Table 2: High Pressure Piping specifications of various base materials of a NS 10" pipeline

Material	Schedule	Wall thickness	Weight
		mm	kg/meter
Safurex®	80	12.7	82
316L Urea Grade	160	28.6	172
25-22-2	120	21.4	133

Table 2 shows the High Pressure Piping specification of various base materials of a NS 10" pipeline. It shows that a Safurex® High Pressure pipeline only needs a schedule 80 and its wall thickness is only 44% of the wall thickness of a 316L Urea Grade pipeline and 59% of a 25-22-2 pipeline while its specific weight is only 48% and 62% respectively. Savings in weight translate directly in savings in costs.

For pipe sizes of 12" and higher it is even possible with Safurex® to downsize, which means that one can choose a 12" Safurex® High Pressure pipeline with an internal diameter of 288,8 mm instead of a 14" 316L Urea Grade with an internal diameter of 284.2 mm as is illustrated in the figure below.

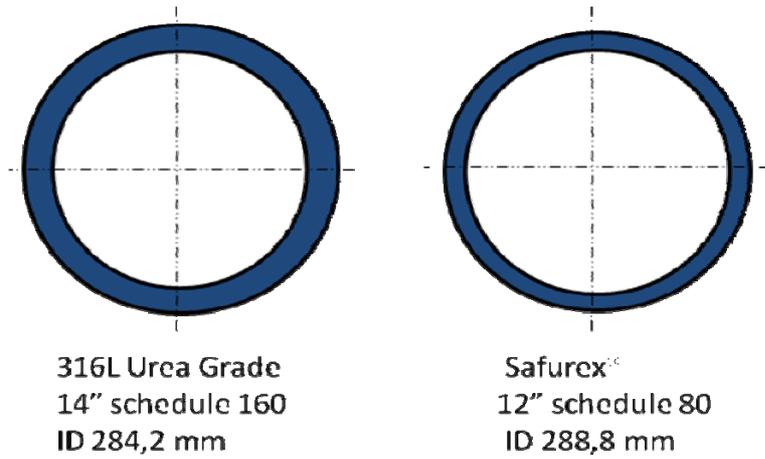


Figure 8: Safurex leads to downsizing of high pressure pipeline for lines of 12" and higher

This downsizing obviously leads to significant additional savings in weight and costs for the High Pressure Pipelines and in several cases also for the High Pressure Control Valves.

Further for High Pressure Control Valves and Fittings, Safurex[®] offers many advantages such as a better corrosion and erosion resistance properties.

4. BHDT facilities and quality control

BHDT currently has some 180 employees of which 13 have a university and 22 a graduated technical education. The headquarters encompass 8500 m² workshop plus some 2500 m² offices. Together with the two other shops BHDT has available 17000 m² workshop and 3500 m² offices. This chapter describes several special features and activities of BHDT.

Deep Hole Drilling of High Pressure Piping

In 1999 BHDT has intensified its Deep Hole Drilling activities with opening of a dedicated High Pressure Tube Manufacturing Center which has been expanded in 2006 to totally 5000 m². BHDT is able to drill High Pressure Pipes with a length up to 21 m with a drilling diameter in the range of 20-355 mm.



Picture 11: BHDT Deep Hole Drilling shop

Pre-fabrication of isometrics

BHDT has all the expertise and experience available to do the pre-fabrication of the High Pressure Piping pipelines. Pre-fabrication of the High Pressure piping in the BHDT shop or at site will assure you the Best Quality and Maximum Reliability.



Picture 12: Pre-fabrication of High Pressure Piping

For the enduser pre-fabrication by BHDT welders means no risk of leakages or corrosion problems during operation and thus no unscheduled shut downs of the plant.

Further pre-fabrication saves precious time during the turnaround and a shorter turnaround saves significant money.



Picture 13: Pre-fabricated isometrics ready for transportation

Welding processes

During the fabrication of the High Pressure Valves and Fittings, BHDT applies various kind of welding processes such as:

- Metal arc welding
 - 25-22-2
 - Sellite, Skwam, Celsit, ...

Tungsten arc welding

- Thin walls
- Roots

Gas metal arc welding

- Full or filler layer
- Flux core wire

Orbital welding



Picture 14 a/b/c/d/e/f:

Different welding processes
Control Valve testing

BHDT has a leading position in the urea industry with respect to High Pressure Control Valves. This is based on providing the Best Quality together with our long time urea experience. Of each control valve BHDT will check the Kv value and perform a leak test.



Picture 15a/b: Control valve testing

BHDT Quality Assurances

BHDT has the following authorizations and Certificates:

- ✓ EN ISO 9001:2000 and AS EN 9100
- ✓ AD 2000, EN 729-2 and ON M 7812-1
- ✓ PED 97/23/EC Module D/D1, E/E1 and H/H1
- ✓ GOST-R and GOST-RTN certificate
- ✓ SCC* for BHDT Service activities
- ✓ ASME U, U2 and U3 certificates in progress



Figure 8: TÜV Quality certificates

And the following Testing Facilities:

- ✓ Pressure and tightness tests (up to 1000 MPa)
- ✓ Impulse testing (up to 400 MPa and 25 Hz)
- ✓ Valve test station for Cv value evaluation (up to NS 300 mm)
- ✓ Ultrasonic examination (manual and automatic test equipment for tubes up to 21 m)
- ✓ Eddy current examination (manual and automatic test equipment for tubes up to 21 m)
- ✓ Magnetic particle and liquid penetrant examinations
- ✓ Hardness tests (stationary and mobile equipment)
- ✓ Measuring of ferrite content
- ✓ Positive material identification check

5. Conclusions

More than five decades of experience have made BHDT well known all over the world as a reliable manufacturer of high pressure valves (angle, globe, check, safety, analyzer, sample and control valves), all kind of fittings (tees, elbows, reducer, nipple, threaded flange, weld neck flange, weldolet, etc.) and prefabricated high pressure pipeline isometrics (spools) especially for Urea and Ammonia plants.

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