



BUTTING in Knesebeck... Experts in clad piping

The use of mechanically lined pipes represents an economically interesting solution in all areas where high pressures and aggressiveness can be found in the media transported. BUTTING is one of the pioneers of this technology and today exports its clad piping products around the world for some of the most demanding and sensitive applications in the oil and gas industry. Stainless Steel World spoke to Managing Director Thomas Schüller about several exciting and unique developments in the company's product offering; glued mechanically lined pipes, a special mechanically lined pipe and clad pipes with upset ends.

By Joanne McIntyre

At the beginning of the 1990s, BUTTING developed the mechanically lined BUTTING-Bimetal-pipe (BuBi® pipe). With the BuBi® pipe, a longitudinally welded BUTTING pipe made from stainless steel or a nickel based alloy is telescopically aligned inside a carbon-manganese steel pipe and mechanically connected by means of a hydro-forming process. This combination allows the very good strength and toughness properties of carbon-manganese steels to be linked with the high

corrosion resistance of stainless steels or nickel-based alloys. For many years BuBi® pipes have been used successfully for demanding and sensitive purposes in the oil and gas extraction industry, mainly in the offshore area – but in the onshore area as well. Examples of typical applications are pipelines or riser pipes for the transport of oil and gas, SCR pipes, water injection lines or pipes for the transport of waste water. These are laid in many different ways: they are suitable for conventional

laying onshore and for offshore laying by S-Lay, J-Lay, bundle or processes. For technical reasons the reel-lay method is, in general, the most cost-effective of these procedures. The cost of laying and thus the laying method have a major influence on the selection of the pipe type for a project. Today and in future, the focus will be on the cost-effectiveness of laying pipes. That was the basis and motivation for a further product innovation. BUTTING has developed



BUTTING clad pipes are transported around the globe by rail, road, sea and air.



Thomas Schüller, Managing Director (left) and President Hermann Butting.

a glued mechanically lined product which can be laid by the reel-lay process, without using inner pressure or increasing the wall thickness of the CRA liner: the GluBi® pipe!
 Thomas Schüller, Managing Director of BUTTING in Knesebeck, is impressed by the innovation: “We know that the laying process is becoming more and more important when clad pipes are selected. At the moment, reeling is the most cost

effective process for laying pipelines and risers. Also, bending of mechanically lined pipes is restricted when reeling. Depending on many factors, such as wall thickness, outside diameter and bending radius, wrinkles may be formed in the liner of a traditional mechanically lined BuBi® pipe. Faced with this problem, we have developed a product innovation that reduces the cost of materials and of pipe-laying.”

Long-standing development work

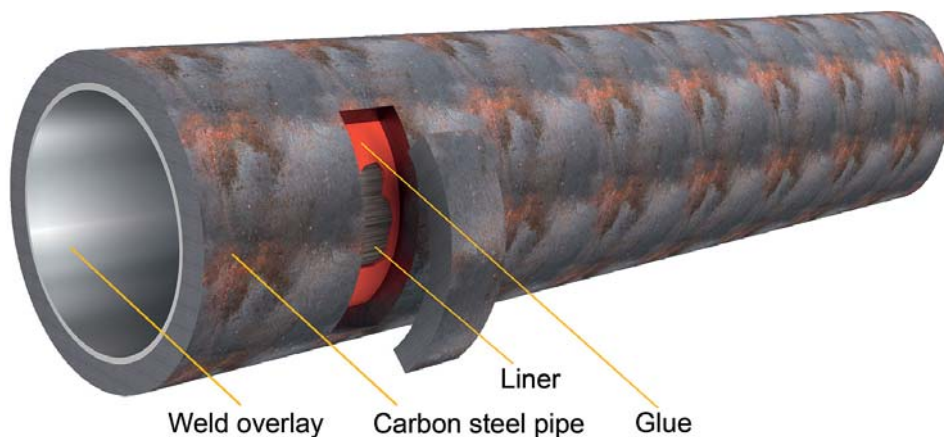
As early as 2000, BUTTING had the idea of a glued pipe. However, it could not be welded and so the development stopped. In 2009, development work restarted. In 2016, BUTTING was able to present a glued pipe with weldable pipe ends to oil companies and the EPC companies (pipe layers). The principle of the GluBi® pipe is very innovative: the basis is a mechanically lined BuBi® pipe, which is provided with an additional special adhesive between the carbon-

manganese steel and the corrosion resistant liner. The choice of adhesive represented a particularly big challenge for BUTTING. In addition to the stringent quality requirements, a number of other conditions applied. The adhesive has to satisfy the following criteria, for example:

- Temperature resistance
- Shear strength
- Flexibility
- Ageing resistance

Wide variety of materials and sizes

There are a number of variants available for the GluBi® pipe – both for the carbon-manganese steel and for the corrosion-resistant liner – and for possible combinations. This variety is based on the materials for BuBi® pipes. An overview of the materials may be obtained from Tables 1 & 2. During the production of GluBi® pipes, very tight tolerances and special quality standards must be complied with. As regards the tolerances, the same requirements can be implemented that have already been achieved successfully with the BuBi® pipes in previous decades.



The GluBi® is a glued mechanically lined product which can be laid by the reel-lay process, without using inner pressure or increasing the wall thickness of the inner liner.

Reproducible production process

The production process for the GluBi® pipe corresponds to 90% of the production process for the BuBi® pipe. Thus a tried and tested process can be employed and its reproducible quality level is universally recognised. Unlike in production of the BuBi® pipe, with the GluBi® pipe the outside surface of the liner is connected to the inner surface of the carbon-manganese pipe by an adhesive, and the pipe ends are specially prepared for weld overlay welding.

Table 1. Possible materials for outer pipe

No guarantee for correctness	Carbon-manganese steel	Minimum yield strength (MPa)	Minimum tensile strength (MPa)
	API X52	360	460
	API X60	415	520
	API X65	450	535
	API X70	485	570

Table 2. Possible materials for inner pipe

No guarantee for correctness	inner pipe	Minimum yield strength (MPa)	Minimum tensile strength (MPa)
	Alloy 825	241	586
	Alloy 625 (Gr 2)	276	690
	904L	220	490
	316L	170	485

The pipe ends are cladded using the gas metal arc welding (GMAW) process with two layers. Here the same welding procedure specifications (WPS) are used as for BuBi® pipes. The result: the pipe ends of the GluBi® pipes correspond to the ends of the BuBi® pipes. Thus the behaviour of the pipe ends of GluBi® pipes during circumferential welding is absolutely identical to the pipe ends of BuBi® pipes.

Simulation of the reeling process

BUTTING is aware that products for the oil and gas industry are subject to the highest quality requirements. Thus as early as 2010, BUTTING developed a test unit to simulate the reeling process and installed it on the site of the main plant in Knesebeck. The test rig makes it possible to simulate many different applications and uses of the pipes. In the past years, a variety of tests were repeatedly performed with GluBi® pipes. For further trials of the GluBi® pipe’s suitability, the outside surface of test pipes were experimentally coated with plastic: the examination of the liner using a camera produced no evidence of wrinkle formation. The temperature strain did not have a negative influence on the adhesive connection.

Ready for market

The first two stages of the qualification process of the GluBi® pipe in accordance with DNV-RP-A203, together with DNV GL, could be completed in the course of the last year. Volker Lahmann, product engineer at BUTTING, adds: “We plan to complete the third stage of the qualification by the end of the second quarter of 2018.” Various tests are still due to be carried out. These include simulations using a finite element model of DNV GL in order to find all factors that may have an impact on the pipe. Later the finite element model shall be used to determine critical factors of different dimensions and material grades at an early stage. Thus it will be possible to define critical temperatures in service and to develop non-destructive testing methods as part of quality assurance, to be able to certify the existence of the adhesive and its performance. Thomas Schüller draws an initial conclusion: “Customers in the oil and gas industry and EPC companies have reacted very positively to the new product and have shown genuine interest. They wish to receive test pipes for further investigations. We will be ready to comply this request in 2018.”

Investments in continuous production process

In order to provide an optimum production process for this product, two new production halls are being built at the main plant in Knesebeck. The layout planning was already available in the middle of last year and immediately after receipt of the building permission, work started in November. It is planned to have the machines and equipment installed during the fourth quarter, 2018. Thomas Schüller: “The new steel equipment is the highlight of our investments: optimum processing of the pipes will be possible, the working conditions of our staff will be improved and our capacities in this production area will be increased considerably at the same time.” He adds: “The continuous production process for the GluBi® pipes will be set up by the end of 2018. Thus our customers will have production capacities for GluBi® pipes in sizes from 6" to 18".” The Managing Director is quite positive that the added value of the GluBi® pipe will convince the customers and that the pipe will establish itself on the market.



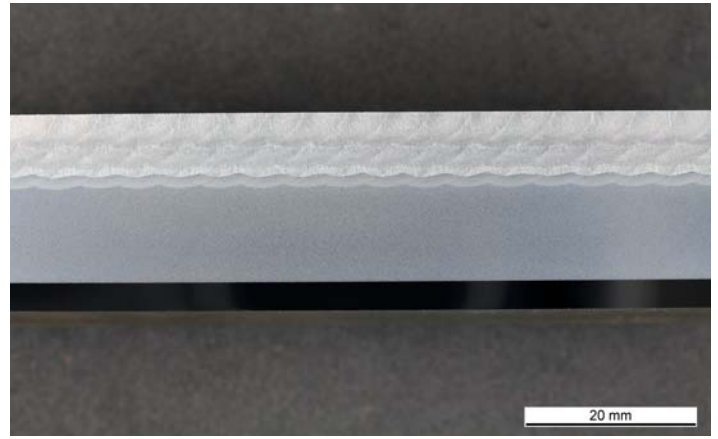
Every pipe is subjected to stringent testing and inspection before delivery.



GluBi® pipe: Simulation of a reeling process; no evidence of liner wrinkling.



Manual UT examination of a weld overlay upset end.



Metallographic cross section of a weld overlay upset end.

Progress by partnership

For a great number of customers worldwide BUTTING is an important partner in the product development process. In January 2018 the qualification of a modified mechanically lined pipe could be completed. Usually, the seamless carbon-manganese steel pipes used for the production of mechanically lined pipes are purchased. For some projects also submerged arc welded carbon-manganese steel pipes were used. BUTTING was addressed by a renowned Norwegian oil and gas company and asked to test a high frequency induction (HFW) welded carbon-manganese steel pipe for the production of BuBi® pipes which can be used for a new offshore project. The weld quality of the HFW pipe is based on a production procedure from Japan. The toughness values of high frequency induction welded carbon-manganese steel pipes obtained hitherto were insufficient. Thanks to a new procedure and further development very good values could be achieved in those temperature ranges that the pipes are subject to in service.

Thomas Schüller comments: "It is always a pleasure for us to support our customers in innovative processes. Also in case of this specific project it was exciting for us to join the qualification programme of the modified product."

For the qualification a high frequency induction welded steel pipe in the size 20" and a wall thickness of 22 mm was produced for the first time. Together with the customer an extensive qualification programme was prepared. Thomas Schüller: "After the successful completion we were pleased to note that the HFW welded outer pipes are a third alternative beside the submerged arc welded and seamless carbon steel pipes."

The advantages of this pipe are obvious: less production costs and very good mechanical-technological properties, e. g. low-temperature toughness.

New development: clad pipe and lined pipe with upset ends

In case of offshore pipelines transporting media from deep sea waters, partly very long riser pipelines are necessary to connect the pipe systems at the bottom of the sea to the floating platforms (FPSO = Floating Production Storage and Offloading Unit). They are subjected to very high alternating stresses (vibrations) due to the currents at sea, weather conditions etc. which can vary enormously in some areas of the pipe system. The pipes used in areas where stresses are extremely high require specific design. As the circumferential weld joining individual pipe segments generally is the weakest area in a pipeline riser, special care has to be taken to alleviate the stress potential here. Sometimes, pipes are used with a higher wall thickness over a defined length at the ends (depending on the design) thus increasing the cross section of the weld. The bigger the cross section of a circumferential weld, the lower the strain. Joachim Banse, product engineer at BUTTING, comments: "The pipes with so-called upset ends are especially used in the touchdown and splash zones." In case of solid carbon steel pipelines, such thickened pipe ends are achieved by upsetting the ends in a forging process. As regards metallurgically clad and lined pipes, various options for the production of thickened pipe ends are available.

Various methods

The following options are available now:

- a) In some areas of a riser pipeline it is possible to integrate prefabricated

pipe segments with higher walls by welding (workshop conditions). However, this method is not allowed for the critical areas of a riser pipeline under enormous stresses.

- b) Riser pipes (generally in 12 m lengths) are produced with an increased wall thickness over the full length, followed by subsequent machining to achieve the required geometrical dimensions.
- c) Use of riser pipes with higher walls over the entire pipe length from the outset. This option would lead to big weight problems.
- d) The riser pipes are thickened at the ends by overlay welding. However this option is not qualified yet.

Qualification programme for a potential solution

Following a suggestion by the welding technology department at BUTTING, an in-house weld overlay solution was developed last year. The weld cladding was performed on the outer surface of the carbon steel pipe. After the first development approaches had been presented to various oil companies and EPC companies, positive responses to the findings were received. The support and encouragement from these companies was reason enough for BUTTING to continue the development work. Production tests with circumferential welds of various types were carried out together with various pipe layers. Joachim Banse comments: "We want to obtain DNV-GL qualification also for this specific product, true to our motto 'Progress by Tradition'."

Thomas Schüller adds: "In our opinion weld-clad ends offer clear advantages over the other production variants: the production process can be controlled, it is cheaper and reproducible. With this in mind, we at BUTTING prefer weld-clad upset ends."