BENDING FROM THE INSIDE OUT

Paul Waanders, Maats B.V., the Netherlands, describes the benefits of an internal bending machine, designed with externally insulated pipes in mind.

It is not often that there is a completely new piece of equipment presented to the oil and gas industry, but in 2019 Maats is presenting the Maats Internal Bending machine (IB), the first pipe bending machine that is able to cold bend steel pipes from the inside.

Maats has been manufacturing machines for the cold bending of steel pipes from 6 - 60 in. for projects around the globe for several years. These conventional (or external) bending machines are generally used for cross-country oil and gas pipelines, where pipes normally have a 3LPE coating that is only a few millimetres thick.

Although globally there is definitely still a future for natural gas pipelines, currently there is a strong movement in Western Europe that advocates for a drastic reduction

Figure 1. Bending 28 in. pipe with the Maats IB.

in the use of fossil fuels, including natural gas. Although this is not a change that will happen overnight, the need for CO_2 emission reduction and the energy transition that is required to achieve this was a reason for Maats to start exploring other kinds of pipeline construction activities, for instance large diameter pipelines for (sea)water or pipelines used for district cooling and heating. The latter especially because district heating is used more and more for the transport of residual heat from plants and factories to companies and homes, reducing the need for heating with fossil fuels.

To a certain extent, the construction of these district heating pipelines is not that different from gas pipelines, as they both use steel pipe for transport of the medium. This means that the steps of welding and laying are no different from gas pipeline construction. But there are some major differences regarding:

- The weld insulation of the pipes – because for district heating there are several centimetres of PU insulation and a PE casing pipe, as opposed to a 3LPE coating of a few millimetres for gas pipes.
- The bending of district heating pipe – because conventional bending (from the outside) is nearly impossible without compromising the integrity of the external insulation, factory made bends are mostly used.

With extensive experience in the cold bending of steel pipes, Maats has been looking for a solution to simplify the manufacturing of bends for district heating projects. Making factory bends is a time consuming and costly operation; first the bare steel pipe is bent, after which PE segments are brought around the pipe that all have to be weld together at exactly the right angle. After that, the inconsistent space between the steel pipe and the PE casing pipe is filled with PU-foam. The most obvious alternative to factory made bends would be to bend the pipes with a conventional bending machine. All Maats bending machines are equipped with load sensing operating hydraulics; the load sensing system assures that the force applied to the pipe is as low as possible, and therefore provides the greatest chance to prevent any damages to the jacket pipe and insulation.

Despite performing several tests, the conventional bending machines were not found suitable for bending the insulated pipes that are typically used for district heating and cooling (and for heated crude oil lines as well). There is no way to fully prevent damage to the PU thermal insulation, and cracks in the insulation result not only in inconsistent insulation values but also cavities in the insulation can give room to condensation, enlarging the chance for corrosion of the carrier pipe and reducing the lifetime of the pipeline system.

As an alternative, it is possible to use pipes that have a higher density (stronger) foam, but still this is no guarantee that the force needed will not damage the insulation, especially when the steel pipe has a wall thickness that is above normal. Moreover, these non-standard pipes have to be specially made, not only according to a more expensive production process, but also with separate testing, different QA standards, and they have to be stored separately from standard pipes on a project. These are all factors that make it substantially more expensive than a standard pipe.

Figure 2. The Maats IB works from inside a 20 ft container.

Internal bending machine

The new addition to the Maats product range is the IB. These

machines were specially designed for bending pipes that have an external insulation. With these machines, it is possible to bend (so far) sizes from 18 in. up to 32 in. from the inside. As it bends pipes from the inside, there is no force applied on the jacket pipe and insulation – therefore there is no risk of damaging the pipes and insulation properties remain uncompromised. As there is no force applied from the outside, the machine allows the use of pipes that are insulated with a standard density foam of approximately 70 kg/m^3, which has several advantages:

- A better insulation value, compared to higher density foams.
- Pipes have a lower total weight, which means easier transport, handling and storage.
- Pipes are cheaper.

Initially the IB machine was engineered for district heating projects, where steel pipes generally have a limited wall thickness (up to 10 mm), a lower steel quality (P235GH or P355NH) and in general are spirally weld. Maats however sees an equally large potential in using the same bending technique for long distance heated pipelines like for crude oil, sulfur or any other medium that has to remain within set temperature limits. These new applications, along with different specifications, required a further development of the IB machine. This was not an easy challenge, because whilst you can go as big as you want when bending from the outside of a pipe, it is much more difficult to increase the bending capacity when you are limited to the space that is the inside of a pipe.

Maats has now introduced the Maats IB24 to the oil and gas industry. This is designed to bend thermal insulated pipes that contain 24 in. SAWL steel pipe with a steel grade up to API 5L X65, with the following limitations:

- Maximum wall thickness of steel pipe: 21.5 mm.
- Maximum degrees per 12 m joint: 10°.
- Minimum foam density: 60 - 75 kg/m^3.

Since the machine carries out its work from the inside of the pipe, there is no limit to the foam thickness and the outside diameter of the PE jacket pipe. For heated crude oil lines, there often is a raceway connected to the pipe, intended for heat tracing cables. Maats studied the effect of the bending on such a square duct and the conclusion is that bending from the inside of the pipe has very little to no effect on such a raceway, provided that some slight deformation of the raceway can be accepted.

Working inside the pipe is not only restraining the room you have for the machine, it also means that you have no visual reference of the operation of the machine and the exact location of the bending machine inside the pipe. This called for a system that automatically monitors the whole bending process. A large advantage is that registering all parameters in this case also means that you can set them up front. Although such an automated system can have many different settings, ultimately it is possible to pre-programme all parameters to make a required bend. This means that after positioning the machine in the pipe, a complete bend is made with just a single push of a button.

Logistics for use

This bending machine, like all internal bending machines, is conveniently installed in a 20 ft container – making transport easier and cheaper. Power is provided by a separate generator that is supplied with the machine, giving it the needed flexibility to use it on any location. Like all pipe bending equipment, the machine should be placed on an even and stable surface, with sufficient room around the machine to safely feed and remove pipes. For handling the pipes, it is necessary to have a crane/pipelayer with an operator (for assistance there is normally one additional person needed) – a set-up that is similar to conventional bending.

Machine advantages

When comparing bends made with the Maats IB machine to factory made bends, they are not only cheaper in price per metre pipe but there are also several other advantages:

- Easier and cheaper logistics: only identical straight pipes have to be brought to the jobsite, making production and logistics easier and reducing transport costs substantially.
- Easy adjustments on-site: if there is a change in routing or if there are any unforeseen obstacles requiring a slightly different bend, this can easily be undertaken on the jobsite.
- Consistent quality: as standard pipe is used, the insulation thickness is consistent and the insulation values are always the same, without the possible variations when post-insulating bent pipes. Also, the alarm wires are always in the same place.
- Higher productivity: once the machine and the bending team are attuned to each other, it is possible to bend between 8 - 10 pipes per 8 hr shift, depending on the bend angle to be achieved. This is much quicker than making factory bends with post insulation.
- Cheaper pipe: it is possible to use standard pipes with a (normal) low density foam, reducing the price per joint significantly.
- Lower failure rate: as the bending process is largely automated (pre-programmed steps and angles), the effect of human error and therefore the risk of rejected bends is minimised.

With the Maats IB it is possible, in oil and gas projects, to perform field bends for insulated pipes. This relieves any project from the extensive engineering and logistical challenges of designing and distributing factory made bends, because these bends can be easily made from standard joints, on any jobsite, anywhere in the world.