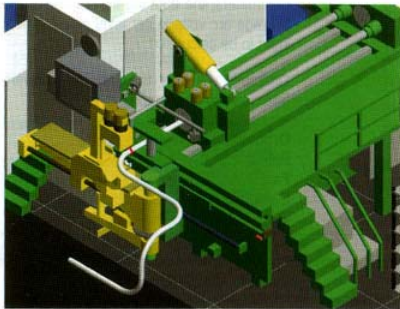


The art of pipe bending benefits from simulation software

Any manufacturer of pipes recognises that the product is rarely required for use in straight lines, and more commonly forms a network akin to a 3D maze (as with engines). This is the reason that the most important element within the construction of pipes is often the elbow.

The only alternative to the inclusion of fittings in a plan is the incorporation of bent pipe. The fittings can be necessary in certain situations, where some aspects of the bent pipe are unacceptable, but generally the inclusion of welded bows will be more expensive than bending.



11 Inductive bending machine, for thick walled pipes with free radius

It is for this reason that when pipe bending, design software should be utilised to predict collision errors and plan a production run. A good machine together with the right software will increase the efficiency of any workshop.

For a better understanding of the substantial difference between pipe bending and fittings, it is important to analyse an example of pipe with four bows (based on \varnothing 100mm). Results comparing welding on fittings against CNC bending indicate that welding can take over twelve times longer than bending. Therefore, bending can lead to both time and cost savings.

There is a wide variation of deforming technologies, often specified in the requirements with pipes to be bent (differences in materials/size), with the most typical diameters of pipes currently being 3mm to 1,626mm. The most important process techniques are cold bending with or without mandrels, hot bending (using induction), and hydroforming (ie tube is highly pressurised during the forming process).

Cold bending is typical on pipes with sizes of \varnothing 3mm to 323.9mm, while pipes with diameters between 88.9mm and 1,626mm can be bent using the hot forming technique. Using the induction technology is the most common approach for the hot forming.

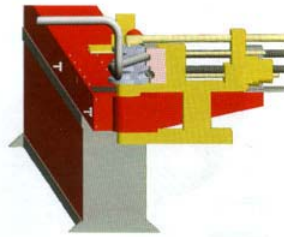
With bending machines, there are considerable differences in features and prices among the approximately 40 different manufacturers of bending machines. The two major questions for the selection of the right machine design are the quantity/complexity of parts to be bent and the size of pipes to be bent.

In principle, there are three types of programs for the data calculation of the bending process. The first is calculation of bending values and pipe length using stretch factor and spring-back; the second is the same but with collision testing on the machine using pseudo bodies; and the third is the same as the first but with collision testing with real bodies, databases and additional calculations.

As discussed above there are two possibilities of forming the pipe: cold or hot. When heat is applied during the bending process, the pipe may become shorter – therefore the straight length between two bends must be lengthened to achieve the same geometric shape.

Hot bending with induction is often carried out using a free bending radius and is therefore more flexible than a cold bending method. With the bending is carried out over the bending die and the radius will spring back and become larger (an effect demonstrated in the photo above).

With the spring-back of the bends the distance between two bows has to be decreased. This calculation must consider the spring-back and stretch factors that depend on material and process aspects.



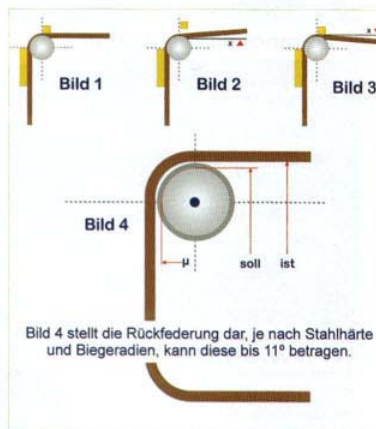
12 Bending machine with two bending dies

In addition to this calculation of bending parameters, there is an alternative that measures the actual angle with an additional sensor and uses the determined value to either perform a corrective bending step or feed a machine database with the results to use it for subsequent processes. This approach is usually the better method if a wide variety of different material is to be processed, but always has the limitations connected to post-measurement techniques that lead to additional, corrective steps.

For the calculation of the pipe length the following aspects must be considered. These aspects include material, diameter and thickness, bending radius, processing speed, spring-back factor, and mandrel type and set-up position. It is essential that for the calculation of the correct bending parameters, software is used.

KOLLI, from 3R Solutions, is machine independent software that also simulates the bending process. It examines whether

13 Desired and actual discharge dimensions



individual pipes can be manufactured on bending machines and supports the operators by calculating the necessary data. When linked to a CAD system, entire pipe systems can be checked, as it is only necessary to provide the machine type that will be used for the bending.

In the event of collisions, the application will suggest possible solutions. One common approach is to extend the straight part between two bows, which will be cut out after the bending. This will cause one weld which is still less effort than two welds (the case if an elbow were used).

KOLLI is also able to check whether it is possible to produce a certain part by reversing the steps and thereby starting the bending process from the other end. The entire bending process can be visualized during the simulation, and details can be