

Bend Pipes (1996 N3.2)

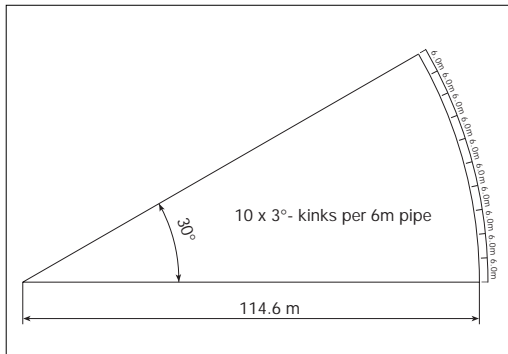
Introduction

Bend-pipes are components of pre-insulated bonded pipes made from straight pipes by bending. Bend-pipes have clearly larger radii in comparison with bends:

- Bend-pipe radius $> 50 \times$ Dsteel pipe
- Bend radius = 1.5 to 2.5 \times Dsteel pipe.

The use of bend-pipes is particularly advisable when the best possible lay out requires a large radius. If for example the bend of a street is to be followed, bend-pipes offer a lay out possibility which means the lowest expenditure with regard to installation lengths, construction site and compensation expenditure with the corresponding radius.

At the realisation of changes of direction with pre-insulated bonded pipes normally 3° kinks are applied for small angles. Larger changes of direction (e.g. 30°) can be realised without statical test by applying several 3° kinks with a minimum distance of 6 m. However, only relatively large lay out radii ($R = 114.6$ m) can be created this way (see picture 1-1).



Picture 1-1: Example of a 30° change of direction with $10 \times 3^\circ$ kinks per 6 m of straight pipe, resulting lay out radius $R = 114.6$ m.

This radius is independent of the pipe dimension. At DN 100 the installation radius is realised with 3° kinks for about $1000 \times$ Dsteel pipe compared with a minimal bending radius at DN 100 of 15 m, that is $130 \times$ Dsteel pipe. Bends frequently cannot be used for such lay

out situations for the very high loads on the little radius of the bend. Bend-pipes on the other hand behave mechanically almost like straight pipes, the load on the bend-pipe is hardly higher than in the straight pipe. Bend-pipes are therefore virtually ideal installation elements for changes of direction between 15° and 70° .

The admissibility of bending at cold installation is differently assessed in Germany. At field try outs at Fernwärmeversorgung Dinslaken with continuous flows in cold installed 3° kinks a temperature lift of 120 K was measured. Further parametric FEM calculations proved, that at this temperature level only installations without kinks are permitted. Changes of direction then had to be created with bend-pipes. According to assessments of Rumpel the opinion should be that cold installed kinks with segment angles up to 5° certainly are able to resist the full temperature lift without larger deformations.

Bend-pipes are no standardised components and are therefore differently laid out and manufactured, resulting in different smallest radii for bend-pipes for different manufacturers. The differences in permissible bending radii depend on one hand on calculation methods, and on the other hand on applied methods of manufacturing. To get a summary of the backgrounds of the offered bend-pipes, the manufacturers became a questionnaire on bonded pipes with the topics

- Laying out of bend-pipes,
- Manufacture of bend-pipes,
- Economy of bend-pipes.

The following explanations are based on the evaluation of this questionnaire which was answered by the manufacturers:

- Pan-Isovit (Germany),
- ABB-I.C. Moller (Denmark),
- Tarco (Denmark),
- Powerpipe (Sweden),
- Isoplus (Austria) .

Summary

Bend-pipes are virtually ideal installation elements since they are mechanically more trustworthy than straight pipes and offer high freedom of installation by allowing many curve angles.

There is not any norm internationally for bend-pipes in which the smallest permitted bend-pipe radius is stated. Therefore many different smallest admissible bend-pipe radii are stated by different manufacturers. These smallest radii are partially manufacturer conditioned, partially due to different installation processes of bend-pipes. Due to planning clearly smaller bend-pipe radii often are possible than those offered by the manufacturers. In the planner's vision this is very un-satisfying.

Therefore all leading European manufacturers of pre-installed bonded pipes were addressed for the questionnaire in the context of this essay on lay out, production and cost of bend-pipes. Five manufacturers from Denmark, Austria, Sweden and Germany have answered this questionnaire.

Answers concerning laying out of bend-pipes confirmed preliminary expectations for large differences with regard to criteria for lay out and the bend-pipe radii resulting. The example enclosed in the questionnaire of a bend-pipe DN 300 with a radius of 20 m shows these differences clearly. The smallest bending radius for such an installation the manufacturers needed up to 50 m. The indicated criteria for the installation differ greatly, now the "highest allowable earth pressure" was mentioned, than the "highest allowable compression in the PUR foam". A unity of criteria for installation seems to be needed urgently to remove the predominant uncertainties.

Clearly smaller differences manufacturers show at the manufacturing of bend-pipes. It is the same at practical all manufacturers:

- Up to the dimension DN 80 bend-pipes are produced on the construction site with the help of transportable bending tools.
- For larger dimensions (> DN 100) bend-pipes are manufactured at the factory, in which in principle up to a dimension of approx. DN 200 the complete pipe is bent.
- For dimensions larger than DN 250 as well complete as separate bending is practised. Bending the complete pipe is limited by the compression of the PUR foam and by the lateral displacement of the PE casing. When bending separately the smallest bending radius is determined by the bending force of the casing. Therefore at small bending radii the PE casing is created by some manufacturers by welding segments.
- At all dimensions elastic bending in the pipe trench on the construction site is possible for several pipes which are welded together.

Costs for bend-pipes manufactured at the factory were indicated by manufacturers as additional costs percentages in relation to straight bonded pipes. The price margin of the manufacturers goes up to 200 % from 115 % in which 100 % apply to the straight pipe. Single manufacturers have mentioned price details depending on the dimensions of the pipes. On the average one can use the following additional costs for bend-pipes:

< DN 300	120 - 130 %
DN 300 - 600	140 - 160 %
> DN 600	160 - 200 %

The economy of use of bend-pipes with assumed changes of direction at two examples of 45° and 15° are not rejected.

In conclusion a current project experience was described to reveal problems that may appear at using bend-pipes at a DN 800 transport pipeline.