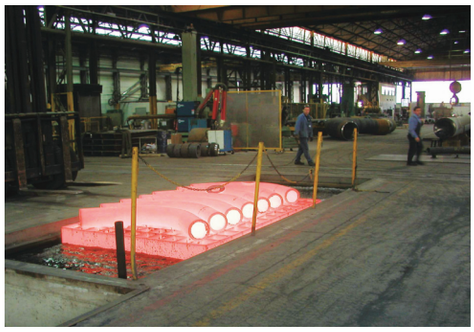
Hot Induction Bends

Tenaris offers hot induction bends using a process that improves mechanical properties.



Tenaris's industrial experience with bends produced by HIB followed by off-line full Q&T shows uniform mechanical properties and no corrosion failures.

Background

Bends for Line Pipe projects can be produced using two different manufacturing processes. In the traditional method, Hot Induction Bending (HIB) is followed by Stress Relieving (SR). With the second process, HIB is followed by off-line full quenching in a tank plus tempering (Q&T). Although the traditional method is fast and less expensive, Q&T produces a more homogeneous product.

Aim

Two years ago, Tenaris, working with European benders, started a full characterization program to compare the quality achieved using both manufacturing processes. The program covered seamless pipe in X60 and X65 steel grades with a dimensional range from 168.3 (6-5/8") to 508 mm (20") OD and 8 (0.315") to 30 mm (1.180") WT. The most important parameters of the HIB were explored (bending temperature, strain rate, chemical composition, on-line quenching and stress relieving conditions).

Special interrupted hot tensile tests on mother pipes were also performed to characterize the hot deformability behaviour as a function of the chemical composition, grain size, deformation temperature and strain level. Data collected during the hot tensile tests helped to define the set up parameters of the trials performed and increased understanding of how the process affects bends metallurgy.

Results

The traditional process gives place to less homogeneous microstructures among the different portions of the final bend (tangent lengths, transition zones and bend body), as well as between the different characteristic axes (extrados, intrados, upper and bottom neutral axes).

The different thermomechanical processes that each portion of the pipe undergoes lead to different expected final properties in terms of yield strength, charpy, hardness and corrosion resistance.

Even when the process parameters are properly controlled, the transition zones undergo different thermomechanical deformation than the bend body, and failures are often located in these areas.

Tenaris's characterization program analyzed as-bent samples and tempering curves. The results showed microstructures that were more than 50% ferrite, revealing the low quenching efficiency of the on-line water cooling.

Hot deformability test performed on different steels showed a very common yielding mechanism.

Results of these trials were compared to Tenaris's industrial experience with bends produced by HIB followed by off-line full Q&T. Bends produced with this process showed uniform mechanical properties (tensile and charpy) and no corrosion failures (HIC and FPBT).

Conclusions

The off-line full Q&T method produces more homogenous bend properties, which can lead to better performance.

Based on the analysis, Tenaris encourages customers to consider the reasons why the off-line full Q&T is the preferred process for demanding applications, such as high steel grades, heavy wall thicknesses, low design temperatures and sour service.

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