Investigation on Strain-age of Large Diameter and Thick Wall X80 Grade Cold Bends
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ABSTRACT

Based on the three different bend radii consisting of 18D, 24D and 35D (D is the diameter of steel pipe), cold bending tests of Φ1219mm×22mm X80 longitudinal submerged-arc welding line pipes were performed. In order to fully understand the effects of cold bending processes on the configuration and performance of X80 steel pipe, the strain aging of X80 cold bends was investigated in this paper. The results of non-destructive and macrograph examination of the welding seam show that the effect of the bending process on the quality of welding seam is not obvious. The inspections show that serious distortions occur during bend of 18D radius of curvature. The mechanical property test results indicate that the change of the transverse tensile property, roughness, hardness and bend performance of cold bends manufactured by various radius of curvature compare with the mother pipe is relatively small. The changes of longitudinal tensile properties are bigger. When the radius of curvature is decreased, the yield strength and yield ratio in intrados of bend decrease, but those in extrados of bend increase. The longitudinal tensile curves in different position of bend exhibit a rather large difference. After the strain-age for mother pipe and bends, the effects of material deformation in the pipe production process appear which result in that the transverse tensile strength and yield ratio increase. There is a larger change of longitudinal tensile property as evidenced by the larger increase in extrados yield ratio.

KEY WORDS: cold bend; radius of curvature; mechanical property; yield ratio

INTRODUCTION

The pipeline is an important means for gas transportation. In order to decrease the construction cost of pipeline, high grades of pipeline steel pipe need to be adopted[1-2]. In the second west-east gas transportation project of China, X80 pipeline steels were used widely[3]. The total consumption of X80 steel exceeded 2500 thousands tons.

The cold bend is a kind of connecting piece used widely in gas pipeline. According to the design demand, the pipe is bent to the proper angle, to account for the change in pipeline direction. For lower strength steel pipes, such as grades below X70, deformability has been proven in a large amount of pipeline projects worldwide. For X80 pipeline steel pipe, no mature field application can prove its cold bending ability, and the properties of X80 cold bend are uncertain. In this work Φ1219mm×22mm X80 longitudinal submerged-arc welding line pipes used in the second west-east gas transportation project were subjected to cold bending tests to research the effects of cold bending processes on the properties of X80 steel pipe. In order to fully understand the effects of cold bending processes on the configuration and performance of X80 steel pipe, the strain aging of X80 cold bends were investigated in this paper.

TEST MATERIAL AND COLD BENDING TESTS

The steel pipes used for cold bending tests are Φ1219mm×22mm X80 longitudinal submerged-arc welding line pipes. The partial material composition of welding pipe is shown in Table 1.

In order to research the effects of different cold bending processes on the properties of steel pipes, three different radii of curvature were adopted in field cold bending tests. The cold bending tests schemes are shown in Table 2. Each bend angle corresponds to a special radius of curvature. The greater the bend angle, the greater the deformation degree of cold bend. The locations of cold bends are shown as Figure 1.

Table 1 Partial material composition of welding pipe (Wt%)

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>CE Pcm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe body</td>
<td>0.059</td>
<td>0.23</td>
<td>1.75</td>
<td>0.011</td>
<td>0.0025</td>
<td>0.23</td>
<td>0.018</td>
<td>0.013</td>
<td>0.18</td>
</tr>
<tr>
<td>Weld seam</td>
<td>0.060</td>
<td>0.30</td>
<td>1.94</td>
<td>0.015</td>
<td>0.0039</td>
<td>0.14</td>
<td>0.140</td>
<td>0.018</td>
<td>/</td>
</tr>
</tbody>
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