End Formation of a Round Tube into a Square Section having Small Corner Radii

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Abstract:

Expansion and reduction are the two common end forming processes for tubes. In the tube end expansion process using a square punch, it is difficult to obtain a small corner radii due to the stretching of the tube around the punch corners. The wall thickness around the corners is small when compared to the side wall. Hence, a tube having a poor square look is formed. In this study, a 2-stage end expansion of a round tube end into a square section having an improved square look i.e. small corner radii and increase in wall thickness around corners is developed. In the 1st stage, the tube end is flared into a cone shape using a 30° conical die by axial compression. In the 2nd stage, the conical end of the tube is drawn through a taper square die using a conical bottom square punch, and a near square section is formed. A 15% ironing ratio is applied during the drawing process to flatten the side wall of the square. Experimental and FEM simulation were performed to evaluate and to verify the forming process. Although the height of the square section increases when the punch stroke at the 1st stage is increased. However, this increase is limited by the buckling of the pipe at the circular section of the thick blank tube. Since the conical end is drawn into a square section having different radial lengths, the bottom of the square section is uneven. The uneven bottom end is trimmed off in the later process. A square section having a maximum height of 32 mm after trimming is successfully obtained from the experiment for the punch stroke, $S = 44$ mm using an API 5 L tube.

Keywords:

End forming; Tube expansion; FEM simulation; Local thickening; Small corner radii

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