Loading path optimization of tube hydroforming process

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Abstract

Optimization methods along with finite element simulations were utilized to determine the optimum loading paths for closed-die and T-joint tube hydroforming processes. The objective was to produce a part with minimum thickness variation while keeping the maximum effective stress below the material ultimate stress during the forming process. In the closed-die hydroforming, the intent was also to conform the tube to the die shape whereas in the T-joint design, maximum T-branch height was sought. It is shown that utilization of optimized loading paths yields a better conformance of the part to the die shape or leads to a higher bulge height. Finite element simulations also revealed that, in an optimized loading path, the majority of the axial feed needs to be provided after the tube material yields under the applied internal pressure. These results were validated by conducting experiments on aluminum tubes where a good correlation between the experimental results and simulations were obtained.