Ali Adel Battawi, "Experimental and Numerical Simulation into the Effect of Axial Feed on Material Formability in a Tube Hydroforming Process", University of Technology, Department of Machines and Equipment Engineering. MSc. Supervised: Dr. Sadiq Jaffar Aziz, 2013, 119 pages.

Abstract

Tube hydroforming (THF) is a new technology of metal forming processes, in which tubes are formed to take the shape of the die cavity, using internal pressure and axial compressive feed.

In this study, two groups of analysis were carried out for two types of materials (annealed Aluminum and annealed Copper tubes) in order to study the effect of axial feed on material formability. In the first group, the internal pressure was kept constant (same pressure level for all test), and the amount of axial feed was varied leading to an increase in the tube wall thickness at each increase in the axial feed and decrease the maximum stress below the material ultimate stress. While for the second group, both internal pressure and axial feed were varied for both material conditions, it was shown that a bulge height increased as compared with previous group due to the high internal pressure that was used, also some tubes were observed to have an excessive thinning in protrusion area (more than 25% from the tube initial thickness) [1] due to the sufficient amount of axial feed which was not provided.

Two dimensional T-shape type was modeled using FEA (ANSYS 11.0 program) depending on the mechanical properties obtained from the tensile test to determine the boundary conditions (internal pressure and axial feed) necessary for this study before starting the experimental work.

Designing and manufacturing a symmetric dies, with the same geometry was used in FEA with dimensions (210×120×60 mm) to form a tube blank of 25.4mm tube diameter 140mm long and 1.6mm initial thickness. In addition, a hydraulic pressure system was also manufactured to provide the required pressure level necessary for the experimental work.

Forming limit diagram (FLD) was experimentally investigated to indicate the safe and failure zones of the forming process for both materials. Also, a square grid was printed on the surface of all tubes with dimensions (2.5x2.5 mm), in order to obtain the strains results from the tubes after deformation, using image processing technology in MATLAB program.

Thickness distribution along the tube length and bulge height results obtained from the numerical simulation were in good agreement with those obtained from the experimental work. Another simulation results were accomplished in this study regarding the distribution of stresses along the longitudinal axis of the tube in von Mises, it was found that the maximum stress decreases gradually at each increase in the axial feed and thereby improve formability. Further simulation was conducted in order to study the maximum internal pressure that can be applied for every axial feed used in this work before start thinning, in order to get the maximum bulge height with an accepted wall thinning.

Keywords: Tube hydroforming process, forming limit diagram, Finite element simulation (ANSYS. 11.0), T- shape die.