Recent Developments and Applications of Tube Hydroforming Technology

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Abstract

Tube hydroforming (THF) processes have become popular in recent years, due to the increasing demands for lightweight parts in various fields, such as bicycle, automotive, aircraft and aerospace industries, etc. The performance of tube hydroforming technology involves machine design, material property evaluation, friction effects, die design, process control, etc. Therefore, design guidelines and some analytical or numerical approaches for accomplishing a tube hydroforming operation are mentioned in this paper. Magnesium alloys have been widely used in computer, communication, and consumer electronics (3C) products and automobile parts for lightweight and other excellent properties. Tube hydroforming of magnesium alloys at elevated temperatures is also introduced. A design guideline for the die shape in T-shpae hydroforming with different outlet diameters is proposed. Finally, some products using THF technology applied to automotive and bicycle industries in Taiwan are also introduced. Manufacturing of irregular bellows with small corner radii and sharp angles is a challenge in tube hydroforming processes. Design of movable dies (Fig.1) with an appropriate loading path (Fig.2) is an alternative solution to obtain products with required geometrical and dimensional specifications. In this paper, a tube hydroforming process using a novel movable die design is developed to decrease the internal pressure and the maximal thinning ratio in the formed product. Two kinds of feeding types are proposed to make the maximal thinning ratio in the formed bellow as small as possible. A finite element simulation software "DEFORM" is used to analyze the plastic deformation of the tube within the die cavity using the proposed movable die design. Forming windows for sound products using different feeding types are also investigated. Finally, tube hydroforming experiments of irregular bellows are conducted and experimental thickness distributions of the products are compared with the simulation results to validate the analytical modeling with the proposed movable die concept.

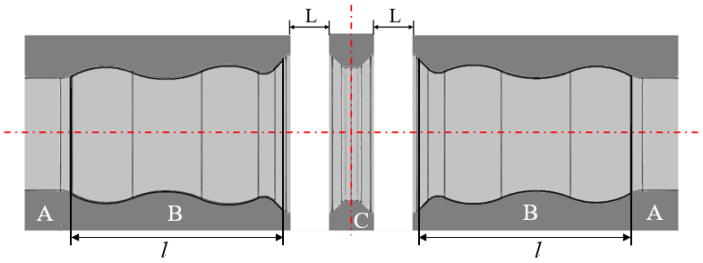

Fig. 1 Configurations of movable die set

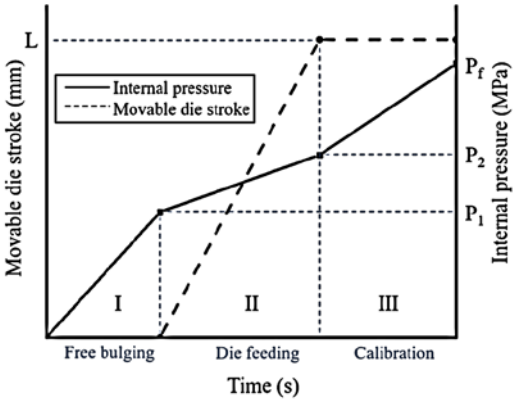

Fig. 2 Designed loading path in hydroforming process with movable