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Punch Design for Floating Based Micro-Tube Hydroforming Die Assembly

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Abstract

Conventional punches used in tube hydroforming (THF) are hollow to facilitate supply of pressurized fluid to the die cavity. The fabrication of hollow micro-punches for micro-THF which can sustain punch loads presents a challenge. This study proposes different types of micro punch designs that can be used in conjunction with floating based micro-tube hydroforming (THF) die set-up. Finite element analysis was carried out to determine the feasibility of the proposed punch design variants followed by Micro-THF experiments. The experiments were carried out to hydroform Y, T, and bulge shaped parts from SS 304 1mm and 2mm tubular blanks. The study has demonstrated that notched punches can effectively be used in micro-THF. The major benefit of using notched punches is that, longer micro-punches with the desired strength can be fabricated with ease using electrical discharge machining (EDM).

Keywords: micro tubes, hydroforming, micro punch design

1. Introduction

Micro-Tube Hydroforming (THF) is a material forming process that utilizes pressurized fluid in place of a hard tool to plastically deform a micro tubular material into a desired shape. The process has the potential to produce complex micro-tubular shapes for applications in various fields such as electronics devices, medical devices, microfluidics devices, and micro-electrical mechanical systems. This technology is still it its infancy stage with numerous technical challenges that need to be investigated. The major challenges confronting micro-THF are briefly summarized below:

Severe tribological performance as the surface to volume ratio increase in micro forming: Tiesler et al (1999) carried out double cup backward extrusion experiments to study the effect of miniaturization. They found that the friction factor can increase by a factor of 20 when micro samples were used as compared to macro samples. Engel, et al (2006) pointed out that the severity of tribological performance in micro forming is largely attributed by the high ratio of open to closed lubricant pockets on micro parts. Bunget and Ngaile (2011) carried out finite element simulation on backward cup extrusion at different cup wall thickness and found that as the wall thickness reduces to a micro level, the ratio of friction energy to the total energy

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