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Advanced Metal Forming

Introduction

Metal forming is the process of creating metal parts by mechanically deforming the material. Typically, the resulting parts are relatively simple, compared to the highly detailed geometries that can be achieved through subtractive (e.g. machining) or additive (e.g. 3D printing) processes. There are, however, some advanced metal forming techniques that can not only produce complex parts, but also offer key benefits over other manufacturing methods.

Background

This document describes three metal forming processes that are essentially variations of blow molding. Blow molding first appeared as glass blowing, where molten glass is inflated using a blowpipe to form hollow shapes like bottles or vases.

This technique is also used for plastics, which is how a typical PET water bottle is made. The plastic is first formed into a parison by injection molding, then inserted into a die where pressurized air is used to force the plastic against the inside of the die. Once the part has cooled and hardened, the die opens up and the finished bottle is ejected.

Solution Details

Tube Hydroforming: This is similar to blow molding, except the base material is a metal tube and hydraulic fluid (typically water with some additive) is used instead of air. High-pressure pumps inject the fluid into the tube, which is surrounded on the outside by a die. This forces the tube to expand to match the shape of the die, resulting in a formed part. This process typically occurs at room temperature.

One of the largest applications for tube hydroforming is in the automotive industry to produce strong yet light, unibody structures. It is also commonly used in creating parts for bicycle frames. Tuning the parameters of the process can be challenging, but the rewards include tight tolerances and smooth finishes.

Tube Hot Gas Forming: Similar to hydroforming, hot gas forming also uses an enclosing die to define the outside profile of the part. In this process, however, inert gas is used to pressurize the inside of the tube against the die cavity. Hot gas forming typically involves heating up the stock material before forming it. The elevated temperature allows the metal to flow more readily, so the pressure requirements are lower and finer details can be achieved in the

part. Tube hot gas forming is commonly used in the automotive and aerospace industries, but it was first developed for creating the swooping shapes found in plumbing fixtures.

Sheet Hydroforming: Sheet hydroforming is a related process that begins with flat sheet metal rather than a tube. In this case, a bladder is filled with pressurized liquid to act as a male die, which forces the sheet metal against a female die to shape the part. For that reason, the process is also known as bladder forming or flexforming.

A major advantage of sheet hydroforming is that it can produce complex parts with a simple die – only the female half needs to be machined, as opposed to a multi-stage stamping tool. This enables fast prototypes with low tooling costs. This process is used for parts such as light fixtures and satellite dishes.

Conclusion

This white paper is intended to be a high-level overview of some related types of advanced metal forming. Several options exist, and the choice for the most appropriate process will depend on the geometry and characteristics of the desired part.

While traditionally used to produce large parts (e.g. for aerospace), these processes can also be adapted for the smaller form factors of consumer electronics. Mindtribe can help you select the best process for your project and can work with vendors to apply advanced metal forming not only to mass production, but also to low-volume runs and prototyping.