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Automotive component development by means of hydroforming

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Hydroforming 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. This technology is relatively new as compared with rolling, forging or stamping, therefore there is not much knowledge available for the product or process designers. Comparing to conventional manufacturing via stamping and welding, tube (THF) and sheet (SHF) hydroforming offers several advantages, such as decrease in workpiece cost, tool cost and product weight, improvement of structural stability and increase of the strength and stiffness of the formed parts, more uniform thickness distribution, fewer secondary operations, etc. The paper presents extensive possibilities of component development in automotive industry by means of hydroforming processes. There are also presented some examples on computer modelling of these processes and limiting phenomena.

Keywords: *hydroforming, THF, SHF, FEM*

1. Introduction

Hydroforming uses fluid pressure in place of the punch as comparing with a conventional tool set to form the component into the desired shape of the die. Generally, hydroforming processes would be classified as tube or sheet hydroforming depending on the initial shape of workpiece. In the tube hydroforming process (THP), the initial workpiece is placed into a die cavity, which corresponds to the final shape of the component, Figure 1. Next, the dies are closed under the force and the tube is internally pressurized by a liquid medium to effect the expansion of the component (internal pressure, p_i) and axially compressed by sealing punches to force material into the die cavity (axial force, 2). Hence the component is formed under the simultaneously controlled action of p_i and axial force. The process should be controlled to avoid failures such as buckling, wrinkling and bursting.

Appropriate fundamentals to determine process controls were developed by experimental approaches as well as by means of FE simulations, e.g. [1–6]. Water–oil-emulsions are typically used media to apply internal pressure, which is usually increased to 250 MPa, and in certain cases up to 600 MPa. The necessary amount is influenced significantly by the wall thickness of the component, the material strength and hardening as well as by the component shape [7–10].

The hydroforming is very useful for producing whole components that would otherwise be made from multiple stampings joined together. For example, a typical chassis component that would normally be made by pressing up to six channel sections and joining by spot welding can be hydroformed as a single part. Other examples of hydroformed parts from automotive industry are shown on Figure 2.

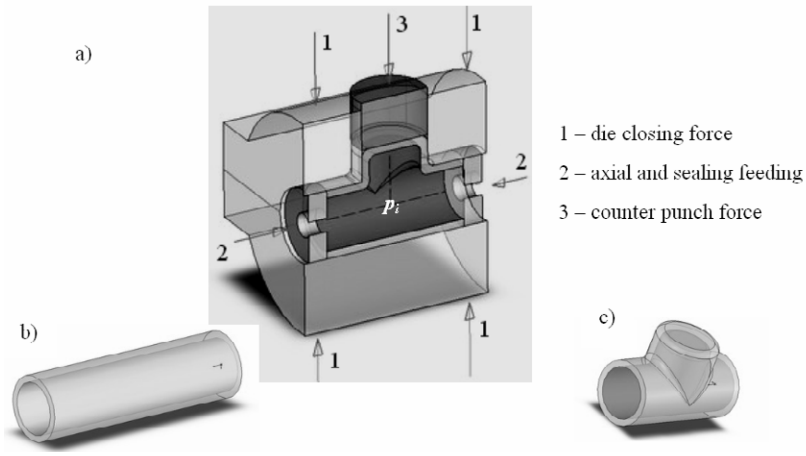

Fig. 1. The hydroforming principles: a – tool setup, b – initial tube, c – final product (T-joint)

In the majority of cases the complexity of the components requires that additional preforming operations are considered together with the hydroforming process itself. These preforming operations can involve bending and mechanical forming of the initial component to ensure that it is capable of insertion into the hydroforming die or to obtain an optimized material distribution [13].

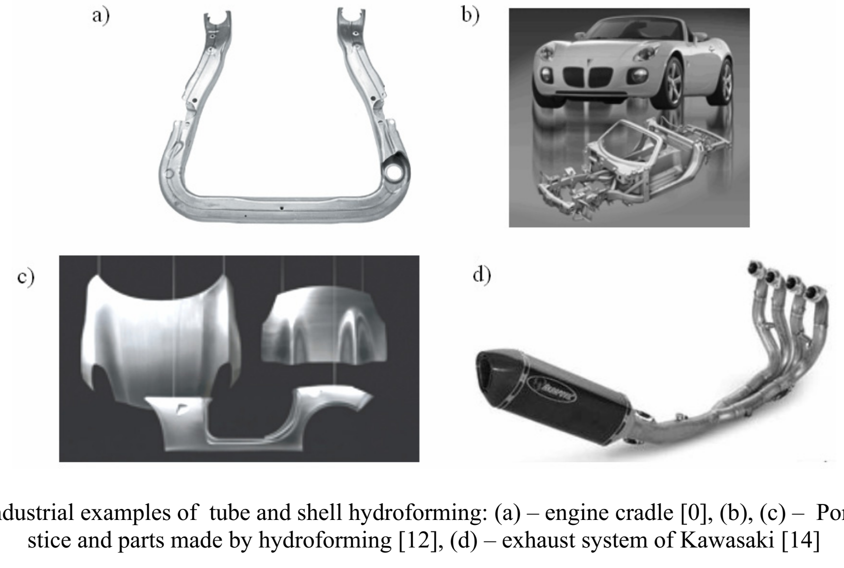

Fig. 2. Industrial examples of tube and shell hydroforming: (a) – engine cradle [0], (b), (c) – Pontiac Solstice and parts made by hydroforming [12], (d) – exhaust system of Kawasaki [14]