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PRODUCTION PROCESS

Optimization of pocket design to produce a thin shape complex profile

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Abstract In extrusion practice surface quality problems like flow lines with thin and varying thicknesses of complex profiles are experienced. Minimization of temperature variance inside the forming zone and velocity variation across the face of the die are particularly important during the metal flow in order to maintain a good quality finish. Several parameters such as shape, depth of pocket, location of die hole and local bearing lengths can be altered to minimize these effects, but fundamental understanding between these parameters and homogeneity of metal flow are very limited in the literature. This study investigates the influence of above-mentioned parameters on the flow behaviour during extrusion for simple and more complex geometries.

Keywords Extrusion · Pocket design · Optimization

1 Introduction

The surface qualities of extruded products depend on process and die design parameters. In order to produce appropriate shapes with good surface quality and homogenous structure the metal flow through the die should be as uniform as possible. Therefore the estimation of an optimal set of process and die design parameters for a particular product geometry is an important part of an extrusion process.

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The geometry of the product we considered is shown in Fig. 1. We have selected this specific die geometry because the extruded product showed surface quality problems. After anodizing it has white lines along the extrusion direction that make an uneven visual surface. These lines tend to appear at different places on different production runs. They seem to be random in whether they appear or not and when they do, it could be anywhere on the profile. These lines are seen as flow lines.

Flow lines are distinctive surface marks and tangential to the machine direction. They are very irregular in size, shape and position. According to the available literature [7] it is a region of highest shear stress when the extrusion is conducted at room temperature. They are caused by poor alloy design. A poor temperature and velocity uniformity inside the forming zone leads to a change in flow characteristics and layer distribution.

Figures 2 and 3 depict the velocity, temperature and shear stress distribution of the extruded product between the entrance and exit of a die for the given geometry. It shows that the temperature and velocity distributions are not homogenous. Further, we found that the location of the higher stress area is moving with different initial billet temperature. All these results demonstrate the importance to improve the die design. If the profile geometry is simple then the flow can be adjusted by using a curved die. But here the profile geometry is complex and therefore the die is flat. There are several methods available to alter metal flow and temperature distribution through a flat die. More reliable methods are (1) assigning a different bearing length at different locations and (2) inclusion of a pocket (or pre-chamber) in front of the die bearing. Even though the variation of the bearing length at different locations is an effective method to control the metal flow, the tendency for extruded surface defects to occur will increase since