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The effect of selected parameters on temperature distribution in axi-symmetric extrusion process

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Abstract

A numerical method was developed to simulate the transient temperature distributions during forward extrusion process. The computer program simulates the extrusion process and takes into account some extrusion variables such as extrusion velocity, extrusion ratio, die preheat temperature, and percentage reduction in area. It can be seen that the higher the percentages reduction in areas, the higher the temperature rises during the extrusion process. Also, increasing speed of deformation shows an increasing dead zone temperature rise than a more gradual die land temperature rise. It is further seen that extrusion temperature increase is a function of the container temperature.

Keywords: Die land length; % reduction in area; Dead metal zone; Temperature distribution; Speed

1. Introduction

When a material is plastically deformed, a very large part of the work expended appears as heat energy. The temperature generated reduces the flow stress of the material, which consequently makes the energy required for deformation to be reduced. Altan and Kobayashi [1] found that, for large reductions and commercial speeds used in extrusion, temperature increases of several hundred degrees may be involved. They reported that about 95% of the mechanical work of deformation is converted into heat. Some of the heat is conducted away by the tools or lost to the atmosphere, but a portion remains to increase the temperature of the work-piece. Singer and Al-Samarrai [2] attempted to predict the emergent temperature of the product by assuming a simple model in which all deformation takes place, as the metal crosses the exit plane of the die. In their calculations of the heat generation, they considered only axial heat flow, neglecting the container friction. Johnson and Kudo [3] neglected the die material friction and assumed an ideal plastic material for their calculations of the adiabatic temperature increase in an axisymmetric extrusion based on an admissible velocity field.

In 1948 MacLellan [4] suggested the calculation of coefficient of friction in wire drawing directly from experiments by means of a split-die. He did not get good results by this method, Wistreich [5], in 1955, obtained reasonable data adopting MacLellan's experimental technique. Both MacLellan and Wistreich neglected the parallel portion or land of the die even though they thought it was important to include it. In the theoretical equation of drawing stresses derived by Sach's [6] and others, the land in the die was also neglected. In 1961 Yang [7], using Sach's approach, derived a theoretical equation which included the effect of the land and comparison of the values of coefficients from both calculations, including and neglecting land was made. The difference between the coefficients calculated with and without the land was found to be appreciable and hence concluded the inclusion of land of die in both the theoretical and experimental analysis. Avitzur [8]

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