3.9.6 Adiabatic vs. Isothermal Flow

Most present-day solutions for metal forming assume isothermal processing. If the total power spent per unit volume is low and the temperature therefore rises only slightly, or if the processing is very slow and all the heat generated by the processing is dissipated by the environment, then the treatment of the process as an isothermal process is satisfactory. On the other hand, metal-forming processes are performed today with massive deformations and at higher and higher speeds. Under such conditions, most of the work of deformation translated into heat, acts to raise the temperature of the workpiece substantially and the process is closer to an adiabatic process, rather than isothermal.

It should be noted here that in actual metal forming processes, no inherent speed limit is evident. The level of obtainable strain rates is limited by external factors. For example, wire drawing and modern extrusion processes are limited to the rate at which the product can be collected in an orderly manner. In hot extrusion the exit temperature must be limited because of metallurgical consideration. Too much heat will cause deterioration of the properties of the product. To limit the heating and permit cooling of the product, the extrusion must be slowed down.

Treatment of flow through conical converging dies as an adiabatic process requires the application of numerical methods. In Refs. [74] and [75] the solutions given by Eqs. (10) and (11) were applied through an iterative procedure to a workpiece divided into small elements. The flow strength of the material, representing here the material properties, is then treated separately for each element and is considered as a function of strain, strain rates, and temperature. The drawing or extrusion stress and the temperature rise were determined. Further treatment of flow through conical converging dies as an adiabatic process is presented in Secs. {4.1.2} and {5.4} of Ref. [30].

BACK NEXT