Chapter XV

Recognition of Lubrication Defects in Cold Forging Process with a Neural Network

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Abstract

This chapter describes the application of neural networks to recognition of lubrication defects typical to industrial cold forging process. The accurate recognition of lubrication errors is very important to the quality of the final product in fastener manufacture. Lubrication errors lead to increased forging loads and premature tool failure. Lubrication coating provides a barrier between the work material and the die during the drawing operation. Several types of lubrication errors, typical to production of fasteners, were introduced to sample rods, which were subsequently drawn under both laboratory and normal production conditions. The drawing force was measured, from which a limited set of statistical features was extracted. The neural-network-based
model learned from these features is able to recognize all types of lubrication errors to a high accuracy. The overall accuracy of the neural-network model is around 95% with almost uniform distribution of errors between all lubrication errors and the normal condition.

**Introduction**

Cold forging includes many processes such as bending, cold drawing, cold heading, coining, extrusion, punching, and thread rolling to produce a diverse range of part shapes. These include various shaft-like components, cup-shaped geometry parts, hollow parts with stems and shafts, all kinds of upset (headed) and bent configurations, as well as combinations of these geometries. The temperature of metals being cold forged may range from room temperature to several hundred degrees.

Often chosen for integral design features, such as built-in flanges and bosses, cold forging is frequently used in automotive steering and suspension parts, antilock-braking systems, hardware, defence components, and other applications where high strength, close tolerances and volume production makes it an economical choice.

In the cold forging process, a chemically lubricated slug is forced into a closed die under extreme pressure. The unheated metal thus flows into the desired shape.

Upsetting, or heading, a common technique for making fasteners, gathers steel in the head and other sections along the length of the part. In upsetting, the metal flows at right angles to the ram force, increasing the diameter and reducing the length.

A typical fastener manufacturing process uses batch production material transfer. The plant is divided into three main areas:

- Preprocessing that involves descaling and application of lubrication consisting of the zinc phosphate carrier and a soap stearate lubricant coating;
- Primary processing that involves wire drawing and extrusion (cold forging);
- Postprocessing that involves cleaning, heat treatment, and the application of a protective coating.

The lubrication used during preprocessing has a major impact on the productivity of the primary processing area. For example, if preprocessing fails to produce high-quality coated rod or the coating is damaged during the material handling then the output efficiency of the primary processing is decreased. This is a result of increased forging loads and premature tool failure, as well as increased defect sorting and the reprocessing of the coated rod. The lubrication coating must provide a barrier between the work material and die during the drawing operation, while still being sufficiently robust to remain on the wire during the transfer to the extrusion operation, where the wire undergoes multistage deformation without the application of additional lubrication.
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