Analysis of Product and Tooling Defects in Extrusion

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Abstract

Aluminium has been labelled as the “metal of the millennium”. Its applications have a wide range spanning across the sectors of automobiles, locomotives, aerospace, energy, and construction. The primary method for manufacturing aluminium products is through extrusion, a bulk deforming continuous process. The core elements determining the productivity of an aluminium extrusion industry are the extrusion press, manpower expertise, extrusion dies and tools, and extruded products. For both productivity and profitability, maintaining good product quality and reducing scraps is of paramount importance.

The main aim of this work is to thoroughly investigate extrusion product defects. This includes detailed study including definitions, causes, and remedies or preventive measures for all product defects. Product quality is intrinsically linked to tooling or die defects. Dies employed in service are often repaired for maintaining die and product quality. These die corrections also influence the product quality. Another comprehensive study about definitions, causes, and mitigation of die defects and die corrections is also included. One major aspect which governs both product quality and die reliability is the complexity of the extruded profile. More complex profiles tend to generate higher pressures and inhomogeneous metal flow, resulting in product defects. Therefore, a finite element model was used to predict chances/extent of defects possible for a certain shape extruded.

The first study includes detailed description of around 80 different types of product defects, and their classification into major categories and their subsets. Analysing statistically, it was found that roughly half of the defects occur in the press during extrusion, and half occur during various post-processing stages. Major categories and types were blisters and blow holes, scratches, and painting defects. Similarly, 17 different types of die defects were studied. Statistical analysis revealed that a major portion of the defects are caused due to different types of cracking and washout of the die bearing surface. Numerical model was first validated against a previous set of cold extrusion experiments. The verified model was then extended for new shapes to study the maximum pressure and metal flow pattern. A total of six shapes was studied and it was confirmed that more complex shapes have higher chances of defects.

Various papers can be found on individual product or tooling defects in metal extrusion. However, no publications can be found, especially in the last 15 years or so, which covers all product/tooling defects. The detailed studies presented in this work on product defects, die defects, and die corrections are therefore a major contribution for the scientific community, and can be used as a reference work. The work is also of direct utility to the field engineers and other technical personnel in commercial extrusion industry. Lower product and tooling defects
directly translate into higher process efficiency, better product quality, and improved profitability for the industry.