International Journal of Materials Forming and Machining Processes
Volume 6 • Issue 2 • July-December 2019

Optimization of Process Parameters on the Mechanical Properties of Semi-Solid Extruded AA2017 Alloy Rods

Shashikanth Ch, Sree Chaitanya College Of Engineering, Karimnagar, India
G Venkateswarlu, Sree Chaitanya College Of Engineering, Karimnagar, India
Davidson M J, National Institute of Technology Warangal, Hanamkonda, India

ABSTRACT

The extrusion of copper-based aluminium alloys is difficult in the cold state. Extruding these alloys between the solidus and liquidus temperatures offer preferred properties on these alloys. In the present work, AA2017, a copper-based aluminium alloy has been extruded in the semi-solid state. The mechanical and metallurgical properties of the alloy vary at different temperatures between the solidus and liquidus temperatures. The aim of the present work is to optimize the process parameters, namely, temperature of billet, strain rate, approach angle and percentage reduction in area on the semi-solid extrusion of AA2017 alloy. Experiments were designed according to Taguchi experimental design and L9 orthogonal array was used to conduct the experiments. Analysis of variance (ANOVA) method was used to find the significance of every process parameter on the thixo-extrusion process responses. The results indicate that percentage reduction area is the most important factor influencing the mechanical properties of thixo-extrusion specimen followed by temperature and strain rate.

KEYWORDS

AA2017 Alloy, ANOVA, Mechanical Properties, Semi-Solid Extrusion, Taguchi Method

DOI: 10.4018/IJMFMP.2019070101

1. INTRODUCTION

Extrusion is one of the forming processes which is used to produce long and straight metal products with constant cross sections, such as bars, solid and hollow section, tubes and wires (Pearson & Parkins, 1960). In extrusion process, the billet is heated and forced through a die orifice. The products from this extrusion process are in a near net shape. However, the extrusion process requires a high pressure machine to force the metal in the solid state. In addition to that, defects such as surface cracking, oxide inclusion and piping defects can be found in products of an extrusion process (Kalpakjian & Schmid, 2008). Thixo extrusion is an alternative process to reduce these process limitations because it has several merits such as low extrusion force, good flowability, less friction between the dies and the perform materials etc. (Fleming, 1991). The main requirement for semi-solid process is to have spherical and nondendritic particles suspended in a liquid matrix. Spence et al. (Spencer, 1971) developed this process while performing hot tear test on Sn-15 Pb alloy. Large number of process parameters influence the final properties of the semi-solid components, thus contributing to the complexity of the process. Thus, to produce high quality complex products, it is necessary to know the effect of each process parameter on the mechanical and metallurgical properties of the final part.

The literature survey indicates that limited work has been done to assess the effect of process parameters on the final properties and formability of the semi-solid materials, both numerically (Alexandrou et al., 2003; Itamura et al., 2002; Modigell et al., 2002) and experimentally (Alexandrou etal., 2001; Zavaliangos & Lawley, 1995; Zude et al., 2010; Moradi et al., 2009; Bayoumi et al., 2009). Mechanical properties decreases as the forging temperature increases for new α+Ti2Cu alloy and also found intergranular fractures after semi-solid forging at 1050 and 1100°C (Cheny et al., 2009). A new rheoforming technique was used to find the microstructure characteristics and mechanical properties of 2024 wrought aluminum alloy (Guo et al., 2008). Most of the investigators considered only one or two parameters independently and neglected other process parameters (Bayoumi et al., 2009; Cheny et al., 2009; Guo et al., 2008; Kang, 2006; Chow & Kanc, 2000). To get most optimum results in semi-solid process, the most important process parameters, that influence the product quality, namely the temperature of billet, strain rate, approach angle and percentage reduction in the area have to be optimized and thus they have been considered in this paper. Taguchi and ANOVA techniques were used to find the percentage contribution of each process parameter on the mechanical properties. Statistical analysis software MINITAB was used for the design and analysis of experiments and to perform ANOVA analysis.

2. METHODOLOGY

2.1. Taguchi Method

Taguchi suggested a special design of orthogonal arrays, which are the shortest possible matrix of permutations and combinations of the controlling factors. This

Processing of Ultra-High Temperature Ceramics for Hostile Environments

Lingappa Rangaraj, Canchi Divakarand Vikram Jayaram (2013). *MAX Phases and Ultra-High Temperature Ceramics for Extreme Environments (pp. 100-124).*
www.irma-international.org/chapter/processing-of-ultra-high-temperature-ceramics-for-hostile-environments/80030