Multiresponse Analysis in Abrasive Waterjet Machining Process on AA 6351

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ABSTRACT

This study investigates optimal parameter setting in abrasive waterjet machining (AWJM) on aluminium alloy AA 6351, using taguchi based Grey Relational Analysis (GRA) is been reported. The water pressure, traverse speed and stand-off-distance were chosen as the process parameters in this study. An L9 orthogonal matrix array is used for the experimental plan. The performance characteristics which include surface roughness (Ra) and kerf angle (KA) are considered. The results indicate that surface roughness and kerf angle decreases, with increase in water pressure and decrease in traverse speed. Analysis of variance (ANOVA) illustrates that traverse speed is the major parameter (89.7%) for reducing surface roughness and kerf angle, followed by water pressure (5.85%) and standoff distance (2%) respectively. The confirmation results reveal that surface roughness reduced by 16% and kerf angle reduced by 47%. Furthermore, the surfaces were examined under scanning electron microscope (SEM) and atomic force microscope (AFM) for a detailed study.

Keywords: AWJM, GRA, Kerf Angle, Optimization, Surface Roughness

INTRODUCTION

AWJM is a nontraditional mechanical based material removal process which uses abrasives and water together as a medium for material removal action. The advantages of this process like good surface finish, hard materials can easily be cut, and lead to low stresses developed on the machined surface as mentioned by Kovacevic (1991). Selvan et al. (2012) studied the effect of water pressure, traverse speed, abrasive flow rate and standoff distance on surface roughness in cutting aluminium. They found that increase in water pressure reduces the surface roughness. Caydas and Hascalik (2008) developed artificial neural network and regression model to determine the surface roughness on AA 7075. They concluded that the surface striations get increased with increase in jet pressure. Chen and Siores (2003) studied the effect of striation formed on aluminium. They investigated that variation in traverse speed, and jet pressure contributes to increase in the striations developed in the machined part. Tosun et
al. (2013) performed an experimental study on AA 6061-T6 and AA 7075-T6 and established that surface roughness increases with increase in traverse speed on both the alloys. Arola and Ramulu (1997) discussed the effect of surface texture created on machining AA 7075-T6. They revealed that more deformation occurs at the entry point of the jet. Singh et al. (2008) performed a research on aluminium using abrasive flow machining technique. It was observed that surface roughness creep up with increase in the process cycles. Akkurt et al. (2004) recognized that surface quality can be improved on Al-6061 with decrease in the feed rate. Babu and Chetty (2006) investigated the effects of various machining parameters on depth of cut and surface roughness of AA 6063-T6. Their study reported that single mesh size abrasives reduce the surface roughness value.

From the earlier study, it is clear that no work had been carried out on reducing the surface roughness and the kerf angle on AA 6351 using AWJM. The aim of the present work focus in determining the optimal parameters for minimizing the surface roughness and kerf angle. Moreover aluminium has an exceptional thermal and electrical conductivity, which can be easily cut by conventional methods and also by other non conventional methods like wire cut electric discharge machining, electro chemical machining, electro chemical grinding etc. But in all these process the mechanical properties and thermal properties of the work material will be lost. This can be minimized when the machining is carried out with AWJM. Additionally, the machined surfaces were exposed under SEM and AFM for a detailed study on the texture generated under the optimal conditions.

**EXPERIMENTAL WORK**

**Equipment Used**

The experiments were performed on AWJM (S3015) as shown in Figure 1. It has a control system of Siemens 810D, Maximum distance between grating and nozzle is 175mm, nozzle material is made of sapphire and Maximum flow of high pressure water is 3.4litres/minute. Garnet of size 80 mesh was used as abrasives with an abrasive flow rate of 100 g/min.
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