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Experimental Study on Surface Roughness in Abrasive Water Jet Cutting

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Abstract

In the present paper, the effects of material thickness, traverse speed and abrasive mass flow rate during abrasive water jet cutting of aluminum on surface roughness were investigated. GMT garnet was used as abrasive material with 80 mesh. Surface roughness was measured across of depth of cut. The experimental results show that traverse speed has great effect on the surface roughness at the bottom of the cut. It was also discussed the correlation between the surface roughness and other abrasive water jet cutting variables. Based on the experiments, the optimal process parameters for each material thickness were defined.

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Keywords: abrasive water jet cutting; aluminum; surface roughness; traverse speed; abrasive mass flow rate

1. Introduction

The abrasive water jet (AWJ) cutting technique is one the most rapidly improving technological methods of cutting materials. In this cutting technique, a thin, high velocity water jet accelerates abrasive particles that are directed through an abrasive water jet nozzle at the material to be cut. Advantages of abrasive water jet cutting include the ability to cut almost all materials, no thermal distortion, and high flexibility, small cutting forces and being environmentally friendly. Because of these capabilities, this cutting technique is more cost-effective than traditional and some non-traditional machining processes [1]. The mechanism and rate of material removal during AWJ cutting depends both on the type of abrasive and on a range of process parameters. In a review [2] noted that

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80 mesh garnet is the optimum type and size in most cases. A great deal of research has been done to improve the cutting performance and enhance the cutting capacity of AWJ cutting technique, including studies of the mechanism of the AWJ cutting process [3, 4] and modeling for process control and optimization [5, 6, 7]. Especially, kerf shape and quality in AWJ cutting of sheet material have been studied in a number of recent research works [8, 9]. The surface quality is one of the most specified customer requirements and the major indicator of surface quality on machined parts is surface roughness. The surface roughness is mainly a result of various controllable or uncontrollable process parameters and it is harder to attain and track than physical dimensions are. A considerable number of studies have researched the effects of the feed rate, standoff distance, water pressure, abrasive grain size, and other factors on the surface roughness [10, 11, 12]. Thus, it is necessary to have a deeper knowledge about the optimum operation conditions, which will permit us to assure a good surface roughness. The aim of this study was examined the effects of abrasive water jet variables such as traverse speed, abrasive mass flow and material thickness on surface roughness in abrasive water jet cutting of aluminum. The varied surface roughness across the depth of cut was also examined.

2. Experimental procedure

The experiments were conducted on a NC 3015 EB abrasive water jet cutting system with a KMT Streamline ™ SL-V 50 ultra-high pressure pump capable of providing maximum water pressure of 413.7 MPa. Cutting was performed on aluminum plates of different thicknesses 15 mm and 30 mm. The constant process parameters are shown in table 1.

Table 1. Constant parameters and their values.

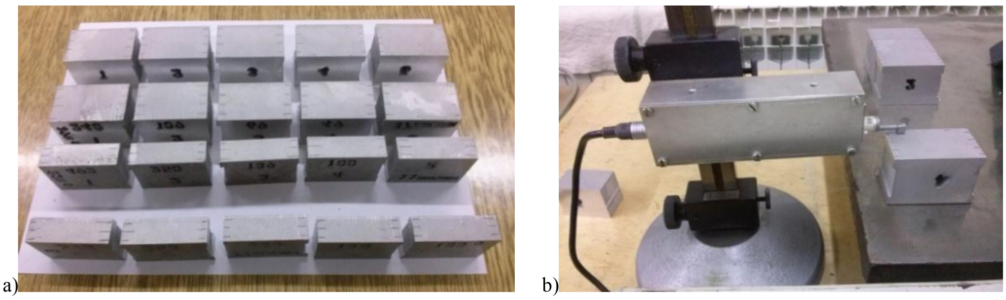
Constant parameters	Orifice diameter	Focusing tube diameter	Water jet pressure	Abrasive type	Abrasive size (grit no)
Value	0.20 mm	0.762 mm	350 MPa	GMT garnet	80 mesh

Two variable process parameters (traverse speed and abrasive mass flow rate) have been selected for the present study, table 2.

Table 2. Variable parameters and their values.

Variable parameters	Traverse speed mm/min	Abrasive mass flow rate g/min
Material thickness 15 mm	77, 100, 139, 250, 350	100, 130, 200, 250, 320
Material thickness 30 mm	37, 49, 69, 109, 130	240, 285, 320, 350, 390

The controlled parameter has been the surface roughness. Surface roughness (with a cutoff of 0.8 mm) on the cut surface was measured in terms of the average roughness *Ra*, using the Surf-Test Mitutoyo stylus instrument; see Fig.1. The measurement of surface roughness was performed in the Laboratory for Cutting Technologies-LaTOOS, Faculty of Mechanical Engineering in Sarajevo. Surface roughness (R*a*) measurements are made at different zones of the cut surface as shown in Fig.2.



a) b)

Fig. 1. (a) the samples with linear cuts prepared for the measurement of surface roughness; b) the measurement of surface roughness.