Experimental Investigation on AWJC Parameter during Machining of Inconel 718 with using Grey Relational Analysis

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Abstract— This Review Paper describes effects of Abrasive water jet cutting on various materials by varying process parameters. Abrasive Water jet cutting is a non- conventional machining. The development of material such as composites and advanced ceramics has a variety of manufacturing challenges. These materials cannot be cut by conventional machining. The high pressure abrasive water jet with abrasive additives called abrasive water jet machine(AWJM). The most important parameters which are directly effecting on cutting performance are traverse speed, hydraulic pressure, abrasive flow rate, standoff distance, and abrasive type, and response parameters which are generally required to improve like surface roughness and depth of cut, MRR.

Keywords: AWJM, Parametric Optimization, Surface Roughness, Depth of Cut

I. Introduction

The abrasive water jets, considering the number of phases criteria, have three phases jets, formed from water, abrasive particles and air. These jets are obtained by injection of abrasive particles in a formed water jet, when air is inserted together with abrasive particles. Today, the abrasive water jet technology is a very competitive nonconventional cutting technology used in a very large area of industrial applications. Fastest growing machining process. One of the most versatile machining processes. True cold cutting process – no HAZ, mechanical stresses or operator and environmental hazards. Not limited to machining – food industry application. The mechanism behind the material removal in conventional AWJM is erosion caused by abrasive particles entrained in high velocity water jet. Cheaper than other processes. Cut virtually any material. (pre hardened steel, mild steel, copper, brass, aluminum; brittle materials like glass, ceramic, quartz, stone). Cut thin stuff, or thick stuff. Make all sorts of shapes with only one tool. No heat generated. Leaves a satin smooth finish, thus reducing secondary operations.

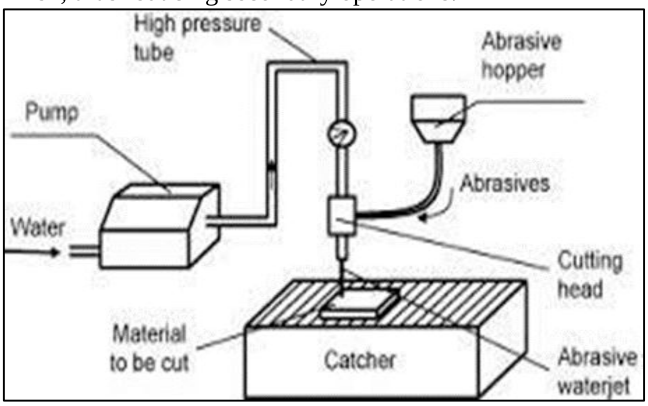

Fig. 1: Abrasive Water jet machine Setup

In addition, for both conventional and abrasive water jet machining the liquid medium will also act as a heat sink, taking heat away from the machining away from the working area

II. Literature review

M.A. Azmir et al. [1] studied Surface roughness (Ra) and kerf taper ratio (TR) characteristics of an abrasive water jet machined surfaces of glass/epoxy composite laminate. They took Hydraulic pressure and type of abrasive materials considered as the most significant control factor in influencing Ra and TR, respectively. They showed that Increasing the hydraulic pressure and abrasive mass flow rate may result in a better machining performance for both criteria. Also they found that the decreasing the standoff distance and traverse rate may improve both criteria of machining performance. They revealed that the Cutting orientation does not influence the machining performance in both cases

Pandu R. Vundavilli et al. [2] developed process modelling of Abrasive Water Jet Machining with the help of Mamdani-based fuzzy logic controller. They have been investigated on depth of cut depends on various process parameters, such as diameter of focusing nozzle, water pressure, abrasive mass flow rate and jet traverse speed. The developed expert system eliminates the need of extensive experimental work, to select the most influential AWJM parameters on the depth of cut. The performances of the developed Fuzzy Logic -systems have been tested to predict the depth of cut in AWJM process with the help of test cases. The prediction accuracy of the automatic FL- system is found to be better than the other two approaches.

Azlan Mohd Zain et al [3] developed a Optimization of process parameters in the abrasive water jet machining using integrated SA–GA on Al 7075-T6 wrought alloy (AlZnMgCu1.5) with using input parameter like Traverse speed, Waterjet pressure, Standoff distance, Abrasive grit size, Abrasive flow rate and output parameter as surface roughness. Simulated Annealing (SA) and Genetic Algorithm (GA) soft computing techniques to estimate optimal process parameters that lead to a minimum value of machining performance. Two integration systems are proposed as integrated SA–GA-type1 and integrated SA–GA-type2. The proposed six modules, which are experimental data, regression modelling, SA optimization, GA optimization, integrated SA–GA-type1 optimization, and integrated SA–GA-type2 optimization. and objectives is that integrated SA–GA-type1 and integrated SA–GA- type2 are to estimate the minimum value of the machining performance compared to the machining performance value with other module, process. The process parameters and machining performance considered in this work deal with the real experimental data in the abrasive water jet machining process. The results showed that both of integration systems managed to estimate the optimal process parameters, leading to the minimum value of machining performance when compared to other module

M.A. Azmir et al. [4] conducted experiment to assess the influence of abrasive water jet machining (AWJM) process parameters on surface roughness (Ra) of glass fiber reinforced epoxy composites. It has been found that the type of abrasive materials, hydraulic pressure, standoff distance and traverse rate were the significant control factors and the cutting orientation was the insignificant control factor in controlling the Ra. They revealed that the forms of glass fibers and thickness of composite laminate showed the greatest influence on Ra. It was confirmed that the determined optimum combination of AWJM parameters satisfy the real need for machining of glass fiber reinforced epoxy composites in practice.

Mahabalesh Palleda [5] conducted experiment to the effect of using different chemicals on material removal rate, with varied stand-off distances and chemical concentration in abrasive water jet machining. They showed that the material removal increases with the increase in S-O-D, up to certain limit and further increase in the S-O-D beyond the limit results in decrease of the material removal. They showed that the chemical concentration was observed to be having an influence over the taper of the holes produced. The hole taper in case of polymer combination showed almost nil taper.

Chidambaram Narayanan et al. [6] modelling of abrasive particle energy in water jet machining. They took process parameter with wide variations in cutting-head geometry, operating pressure, and abrasive mass flow rates. The cross-sectional averaged abrasive particle velocity at the exit of the focusing tube has been predicted with good accuracy over the whole range of experiments

Mustafa Kemal Kulekci [7] investigated work on surface roughness and depth of cut to influence process parameter like water pressure, grain diameters of abrasive feed rate, and traverse speed using experimental data. They found that the two limitations of AWJ are speed and cost of abrasives. When pressurized water is injected through the orifice at 414 MPa, its speed is three times faster than the speed of sound.

Keyurkumar J. Patel [8] investigated quantitative evaluation of abrasive contamination using scanning electron microscopy (SEM) in ductile material during abrasive water jet machining and minimizing with a nozzle head oscillation technique. They indicated that as the depth of cut increases the grit contamination decreases. A comparison was made between straight cutting and oscillation cutting, and it was observed that oscillation cutting is 10 times better than straight cutting for ductile material with respect to particle contamination.

M. Golettia et al. [9] developed Condition monitoring of an ultra-high pressure intensifier for water jet cutting machines with multi-sensor based monitoring approach with using input parameter as ultra-high pressure at (400 or even 600 Mpa) and output as failure of machine component in WJM there are several components that work under extreme fatigue conditions, as the pressure inside the cylinders can reach 400 or even 600 MPa. every critical component is located into the UHP intensifier. In this paper a correlation analysis on multiple signal features with the health status of the machine is presented. Then a multi-sensor based monitoring approach is discussed and tested on a real case study: it is based on the usage of control charts for in-control region definition and possible detection of faults.

Stefan barcik et al. [10] developed Influence of technological parameters on lagging size in cutting process of solid wood by abrasive water jet on Solid wood with input parameter as A feed speed (0.2 – 0.6 m.min-1) and an abrasive mass flow rate(250 – 450 g.min-1) and output parameter as Water jet lagging which can be measured by The amount of energy per a unit of the cut path length can be expressed by means of EDD parameter – distribution of energy density of abrasive particles by Statistical evaluation. Within the monitored technological parameters, we can claim that the increase of the feed speed causes the increase of the AWJ lagging in the cut. The decrease of the abrasive mass flow rate also causes the increase of the AWJ lagging. By a change of the monitored technological parameters the increase of the lagging is not bigger than 1 mm. The AWJ lagging increase is the indicator of worsening of the qualitative parameters of the cut as regards the cutting gap width, cut sides' declination and surface roughness

D.K. Shanmugam Et al. [11] conducted Experimental investigations on Comparative study of jetting machining technologies over laser machining technology for cutting composite materials like (carbon composite and fiber reinforced plastic) with using input as cutting speed and output as the kerf characteristics and surface roughness and study the kerf characteristics and surface roughness of two different materials, carbon composite and fiber reinforced plastic, using abrasive water jet, plain water jet and laser cutting, shows the potential possibility of using those methods. Though using all the methods seemed to be quite possible, Abrasive water jet cutting promises a better cutting compared to the other two. Delamination was sometimes observed as a result of inadequate heat dissipation in laser cutting. Using plain water jet also showed delamination, and abrasive water jet cutting of materials showed some delamination for graphite epoxy composites at very high speeds, but on a general it was very low

H. Y. Zheng et al. [12] conducted Experimental investigations on Quality and Cost Comparisons between Laser and Waterjet Cutting with using stainless steel, mild steel and aluminum alloy with input parameters as Water pressure, cutting speed, Laser power, Gas pressure, abrasive flow rate and outputs as surface roughness, cost. this study showed that The laser can cut thin and less reflective materials such as mild steel and stainless steel, much faster. While for highly reflective or thicker materials, waterjet could cut at relatively fast rates. There is a thickness limit for materials to be cut by laser due to the nature of thermal processing. But the waterjet will be able to cut very thick materials at slow speeds. For the range of materials used in the experiments, the ratio of cutting speeds between laser and waterjet was 0.76 to 0.86 and the laser cutting was more cost effective with good cut quality.

III. CONCLUSION

In the literature review mostly researcher worked on various material like EN31 steel, AISI1017, AISI4140 steel, S235 mild steel sheets, pure titanium sheets, ceramics and ST52 steel all of they have been worked on surface roughness and material removal rate. Survey shows that very few work has done on super hard material from this literature review, it is found that with proper optimization of process parameters of Abrasive water jet cutting precise output with high production can be obtained. The conclusive remarks are very beneficial to the industry people.

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