MODELLING OF ABRASIVE WATERJET MACHINING

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AWJ is a non traditional machining process capable of processing wide range of hard-to-machine materials. This research addresses modeling of the process parameters for this machining technique. To model the process a set of experimental data has been used to evaluate the effects of various parameter settings in cutting 7075-T6 aluminum alloy. The process variables considered here include nozzle diameter, jet traverse rate, jet pressure and abrasive flow rate. Depth of cut is important output characteristics, has been evaluated based on different parameter settings. The ANN method and regression modeling are used in order to establish the relationships between input and output parameters. The pairwise effects of process parameters settings on process response outputs are also shown graphically. The proposed model is then embedded into a matlab algorithm to optimize the process parameters. The objective is to determine proper levels of process parameters in order to obtain a certain level of depth of cut. Computational results shows that the proposed solution procedure is effective in solving many multi-variable problems.

Keywords – AWJM Machine, MATLAB , Surface Roughness Tester.

I. INTRODUCTION

Abrasive waterjet cutting is one of the most recently developed Non-traditional cutting processes. It uses a fine jet of ultrahigh pressure water and Abrasive slurry to cut the target material by means of erosion. AWJ cutting is being used to machine a wide range of non-metals and metals, particularly difficult to cut materials such as marble ceramics and layered composites, due to Its various distinct advantages over other technologies such as high machining versatility, no thermal distortion, ability to contour and small cutting force.

Cutting performance models describe characteristics of the Cut such as kerf width, depth of cut and taper angle, and the development of a Reliable performance model is essential for optimization and control of the AWJ in Industrial applications.

II. Material Properties of Al 7075 T6

Table 1 .Chemical Composition

Sr. No.	**Components**	**Weight in Percentage**
1.	Al	87.1 - 91.4%
2.	Cr	0.18 -0.28%
3.	Cu	01.2 –2.00%
4.	Fe	Max 0.5%
5.	Mg	2.10 – 2.90%
6.	Mn	Max 0.3%
7.	Other, each	Max 0.05%
8.	Other, total	Max 0.15%
9.	Si	Max 0.4%
10.	Ti	Max 0.2%
11.	Zn	5.10 – 6.10%

Table 2. Physical Properties

Physical Properties	**Metric**	**English**	**Comments**
Density	2.81 g/cc	0.102 lb/in^3	AA; Typical

Table 3. Mechanical Properties

Mechanical Properties	Metrics	English	Comments
Hardness, Brinell	150	150	AA; Typical; 500 g load; 10 mm ball
Hardness, Knoop	191	191	Converted from Brinell Hardness value
Hardness, Rockwell A	53, 50	53, 50	Converted from Brinell Hardness value
Hardness, Rockwell B	87	87	Converted from Brinell Hardness value
Hardness, Vickers	175	175	Converted from Brinell Hardness value
Ultimate Tensile strength	572 MPa	83000 Psi	AA; Typical
Tensile yield strength	503 MPa	73000 Psi	AA; Typical
Elongation at break	11%	11%	AA; Typical; 1/16 in. (1.6mm) thickness
Elongation at break	11%	11%	AA; Typical; 1/2 in. (12.7mm) diameter
Modulus of elasticity	71.7 GPa	10400 ksi	AA; Typical; Avg of tension and compression. Compression modulus is about 2% Greater than tensile modulus
Poison's ratio	0.33	0.33	
Fatigue strength	159 MPa	23000 Psi	AA; 500,000,000 Cycles completely reversed stress; RR Moore machine/ Specimen
Fracture toughness	20 MPa-m1/2	18.2 ksi-in1/2	K(CI) S-L Direction
Fracture toughness	25 MPa-m1/2	22.8 ksi-in1/2	K(CI) T-L Direction
Fracture toughness	29 MPa-m1/2	26.4 ksi-in1/2	K(CI) L-T Direction
Machinability	70%	70%	0-100 Scale of Aluminium alloys

III Application of Al 7075 T6

Aircraft fittings, gears and shafts, fuse parts, meter shafts and gears, missile parts, regulating valve parts, worm gears, keys, aircraft, aerospace and defence applications; bike frames, all terrain vehicle (ATV) sprockets.

IV. AIM AND OBJECTIVE

- To improve the depth of cut and quality of cutting by dimensional analysis using following methods
  - Regression
  - Artificial intelligence (A.I.)
- To improve surface finish of workpiece during AWJ Machining process.
- To obtain uniform thickness of kerf width.
- To improve the material removal rate by Abrasive Water Jet Machining.
- To obtain the multiplication factor which will affect the process.

V. LITERATURE SURVEY

1. Literature survey on Modelling AWJ Machining by Regression

Oweinah et al. [1] did experiment on AWJM form energy conservation model to improve depth of cut by considering momentum transfer efficiency co-efficient, average mass flow rate, velocity of nozzle as parameter. The conclusion was that momentum transfer-efficiency co-efficient affect the AWJ Machining. H. Blickweden et al. did experiment on AWJM to improve depth of cut by considering pressure of water, theoretical pressure, velocity of nozzle, by using regression model. The conclusion was that theoretical pressure were regression coefficient affecting the AWJM process.

2. Literature survey on Modelling AWJ Machining by Artificial Intelligence

Pentos et al. [1] did experiment on AWJM to improve effectiveness of the cutting by using ANN method and concluded that, the average value for the group of ANN models for two or more methods for quantifying variable importance which is valuable in actual application. C.Gullara et al. [2] did experiment on AWJM by using ANN method to improve effectiveness of modeling. By this conclusion, the approach was applied to predict absence, presence and abundance of Karlodinium and Psuedo-Nitzchia micro alge in Alfacs Bay

VI. PROBLEM DEFINITION

- Abrasive Water Jet (AWJ) Machining is one of the most recently developednon-traditional cutting processes.

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- It uses a fine jet of ultrahigh pressure water and abrasive slurry to cut the target material by means of erosion.
- All the partials are not able to strike the material due to collision between particles and to the nozzle wall.
- Kerf width of the cut is not uniform as pressure and velocity of jet decreases therefore the cut is taper section.
- The diameter of jet is not similar to the diameter of nozzle therefore width of cut is slightly greater than nozzle diameter.

VII. METHODOLOGY

- A literature survey is to be carried out for selecting various variables for optimization.
- Problem definition and Gap Analysis is to obtained through this survey.
- Objective is set to minimize delamination.
- Test run on CFRP sheet with laser cutting.
- Design Of experiment
- Experimentation
- Measurement of responses
- Optimization
- Confirmation And Result
- Conclusion

Fig. Surface Roughness of AL7075 T6

VIII. EXPERIMENTATION TABLE

CUT NO	AFR (g/min)	TRAVERSE SPEED (mm/min)	SOD (mm)	Ra $(\mu\, mm)$
1	210	140	1	4.801
2	210	180	1.5	4.924
3	210	220	2	5.281
4	210	260	2.5	5.853
5	220	140	1.5	4.827
6	220	180	1	4.865
7	220	220	2.5	5.294
8	220	260	2	5.792
9	230	140	2	4.927
10	230	180	2.5	5.264
11	230	220	1	5.297
12	230	260	1.5	5.681
13	240	140	2.5	4.925
14	240	180	2	5.163
15	240	220	1.5	5.301
16	240	260	1	5.379

IX. CONCLUSI ON

In this study, the effects of process parameters settings on AWJ machining of 7075-T6 aluminum alloy have been investigated. Statistical regression analysis have been employed to develop mathematical models relating such process parameters as water pressure, jet traverse rate, abrasive flow rate to the depth of cut. A set of experimental data, based regression analysis, has been used for model development The purpose of developing the mathematical model is to facilitate the optimization of AWJ cutting parameters. Mathematical model developed to predict the best process parameters values for any desired cutting characteristic.

X. RESULT

Abrasive-jets have a great potential for cutting a wide range of metals. It has been observed that initial cutting is been carried out by water jet itself then , cutting occurs when particles impact the cutting surface at shallow angles due to erosion by abrasive particles. By the equation we get by regression analysis we can predict values of surface roughness & depth of cut without actual machining. But simplified equation was developed that requires further refinement.

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