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Experimental investigation of stainless steel 316 and mild steel A36

B.Sakthivel[1], R.Deepak[2], M.Dhanabal[2], M.Elangovan[2], M.Jayakumar[2]
[1] Assistant Professor, [2]UG Students
Department of Mechanical Engineering, Nandha Engineering College, Erode-52, TamilNadu, India.
[1]*sakthivelme1990@gmail.com*, [2]*djaikumar.1997@gmail.com*

***Abstract*— Abrasive water jet machining process is one among the non- conventional machining processes and extensively used to drilling fired furnace and welded construction of bridges . An attempt is made in this project to measure the material removal rate (MRR) and surface roughness of stainless steel 316 and mild steel A36. Abrasive water jet machining is very promising in processing hard-to-machine materials and machining of stainless steel 316 and mild steel A36 using abrasive water jet machining needs attention. This paper focuses on establishing hole characteristics in abrasive water jet drilling using multi-objective grey analysis. The form and orientation characteristics of the hole are defined using entry and exit hole overcut, entry and exit hole circularity, and depth and surface roughness. The process parameters are water jet pressure, standoff distance, and abrasive mass flow rate. Analysis of variance of the individual responses is used to identify the pattern in which each parameter affects the performance of the process.**

***Index Terms*—– M R R , Surface Roughness, Abrasive water jet machining, Garnet abrasive.**

I. INTRODUCTION

Nowadays abrasive water jet machining is widely used in manufacturing area. In this AWJM a small stream of fine grained abrasive particle is mixed in suitable condition, which is forced on a work piece through nozzle. MRR occurs due to erosion caused by the impact of abrasive particle on the material surface. This process is many suitable for machining of brittle materials, composite materials and ductile materials. In this the technique based on major factor like Jet pressure, Stand off distance of nozzle from the target. Abrasive flow rate, Traverse rate, works materials. In this process, there is no affected zone, low machining force on the work surface and ability to machining wide range of materials has increase the use of abrasive water jet machining over machining process. In this process there is thermal distortion not takes place on the work material.

II. LITERATURE SURVEY

Nivedita Pandey (2012) investigated the drilling on hard material to soft material. This work investigates the controlling of traverse rate and observes the drilling time on various samples and making drill holes on set of materials in AWJM drilling process [1].

Krishnaiahchetty&Kanthababu(2006) has investigated single mesh and double mesh size abrasives using parameters like pressure, traverse rate and abrasive flow rate. Research result revealed that Single mesh size abrasives are found to yield decreased surface roughness than multi mesh size abrasives [2].

Fowler et al (2009) have carried out AWJPM in titanium alloy (Ti6Al4V) to study the effects of different abrasive particle (white and brown aluminium oxide, garnet, glass beads and steel shots) shape and hardness. They have observed that the ratio between the hardness of the work piece and the abrasive particle is more significant than that of abrasive particle shape. They have also observed that increase in the material removal rate and surface roughness with the increase in the abrasive particle hardness. They have observed that among the different input process parameter, traverse rate is found to be more significant for material removal rate for different abrasives They have also found that shape factor and particle hardness have no significant effect on the surface waviness [3].

Selvan et al.(2009)studied the influence of process parameters on depth of cut and surface roughness in abrasive water jet cutting of stainless steel. Experiments were conducted in varying water pressure, nozzle traverse speed, standoff distance and abrasive flow rate for cutting stainless steel plates using abrasive water jet cutting process. Increase of WP resulted in increase in depth of cut when mass flow rate, TS and S.O.D were kept constant, When WP is increased, the jet K.E increased that lead to more depth of cut. Higher AFR achieve higher cutting ability of the jet. But for higher AFR, abrasives collide among themselves and lose their K.E. It was evident that the surface was smoother near the jet entrance and gradually the SR increases towards the jet exit [4].

III EXPERIMENTAL WORK

3.1 Material

In the present study, stainless steel 316 and mild steel A36 was used as a material. This material is hard and soft material used for various application and widely used in fired furnace and welded construction of bridges.

3.2 Equipment

The equipment used for drilling the work piece is Omax 2626 abrasive water jet machining Centre equipped with an abrasive feeder system, a pneumatically controlled valve and a work piece table.

3.3 Experimental Setup

In this present study , we use drilling in hard and soft material traverse speed, stand-off distance and abrasive flow rate. Constant pressure and various angles are considered. The garnet abrasive with size 80 mesh was selected.

Fig.1 Experimental Setup of abrasive water jet

Blind holes were drilled by abrasive water jet machining in SS316 and MSA36 and hole quality was measured in terms of circularity, material removal rate, cylindricity.

Fig.2 drilling of material

Table 1. Machine Specification

Machine Used	OMAX 2626 Precision jet machining Centre
Power	22kW, 50 Hz
Min water pressure	200 MPa
Max water pressure	300MPa
CNC work table size	1168 x 787 mm
Nozzle diameter	0.76 mm
Orifice diameter	0.35 mm

3.4 Chemical Composition

Chemical composition of Stainless steel316 is shown in table 2.

Stainless steel 316	
Chromium	16.00%-18.00%
Nickel	10.00%-14.00%
Molybdenum	2.00%-3.00%
Carbon	0.08%
Manganese	2.00%
Phosphorus	0.045%
Sulfur	0.030%
Silicon	0.75%
Nitrogen	0.10%
Iron	Bal

The drilling rate is the ratio of the thickness of the work piece to the time taken to drill a through hole and is computed with the record of time taken for the jet to make a through hole. Chemical composition of the material decides the machining capability of the material. Depth of drilling also depends on composition of the material.

Chemical composition of Mild steelA36 shown in table 3.

Mild steel A36	
Carbon	0.25%-0.290%
Copper	0.20%
Iron	98.0%
Manganese	1.03%
Phosphorus	0.040%
Silicon	0.280%
Sulfur	0.050%

3.5 Orthogonal L9 array

L9 table shown in the below table 4.

S.no	WP (Mpa)	SOD(mm)	AFR(kg/min)
1	250	1.5	0.24
2	250	3.0	0.34
3	250	4.5	0.44
4	300	1.5	0.34
5	300	3.0	0.44
6	300	4.5	0.24
7	350	1.5	0.44
8	350	3.0	0.24
9	350	4.5	0.34

IV DISCUSSION

In this mathematical method the values are calculated based upon the length, width, depth and time. The material removal rate is calculated by using this formulae

$$M R R = \frac{\text{Length x width x depth}}{\text{time}}$$

Where,
Length (mm), Width (mm), Depth (mm), Time (min)

V RESULTS

The material removal rate and surface roughness, Top circularity and bottom circularity of the taken material is calculated and the values are tabulated in the tabular column on Table 5.

The exercise of different drilling depth on drilling time shows that the relation between drilling time and the depth of drill is not linear. The time to drill as the drilling depth increases are not proportional and the depth is not linear. Further it has been observed that the machinability of the material plays an important role in drilling time in CDM along with the drilling depth. For a difficult to drilling a material (low machinability index), the non linearity effect is more prominent ,the rate of increase in drilling time is higher.

Results of output parameters are shown in below table 5.

S.no	MRR	Ra	TC	BC
1	529.65	2.256	0.0416	0.0249
2	471.73	2.904	0.0324	0.0288
3	469.80	2.150	0.0376	0.0235
4	471.73	2.460	0.0294	0.0301
5	473.67	1.950	0.0324	0.0215
6	450.03	2.611	0.0381	0.0282
7	458.35	2.085	0.0189	0.0202
8	489.35	2.009	0.0421	0.0253
9	472.36	2.119	0.0624	0.0224

VI CONCLUSIONS

The result of experiments shows that drilling time is non-linearly related to material thickness and the machinability of the material significantly influences the time to drill a hole of specified size. For a material with lesser machinability index i.e. one that is difficult to machine, the non-linearity effect is more prominent and the increase in drilling time per unit change in material thickness is more. These results may be recognized to loss of energy and decrease in cutting efficiency due to increase in standoff distance, drop in pressure and infringement of the abrasive particles with chips in the restricted volume.
These results may be attributed to the loss of energy and decrease in cutting efficiency due to increase in stand-off distance, drop in pressure.

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