International Journal For Technological Research In Engineering
Volume 1, Issue 12, August-2014 *ISSN (Online): 2347 - 4718*

PARAMETRIC ANALYSIS OF ABRASIVE WATER JET MACHINING OF ALUMINIUM 6351 T6

Mayur C. Patel[1], Mr. S. B. Patel[2], Mr. R.H. Patel[3]
[1]M.E. Production Engineering Merchant Engineering College.
[2]Asst. Prof., Department of Mechanical Engineering, Merchant Engineering College.
[3]Asst. Prof., Dept. of Mechanical Engineering, S. K. Sankalchand Patel College of Engineering, Vishnagar, Gujarat, India.

ABSTRACT: Abrasive water jet machining (AWJM) is one of the widely used non-traditional machining process. It is capable of machining geometrically complex and hard material components, that are precise and difficult-to-machine such as heat treated tool steels, composites, super alloys, ceramics, carbides, heat resistant steels etc. being widely used in die and mold making industries, aerospace, and aeronautics industries. In present study, Experimental investigations were conducted to assess the influence of Process parameters like Orifice diameter (mm), Traverse speed (mm/min), Abrasive mass flow rate (gm/min) and Stand of distance (mm) on Surface Roughness (Ra) and Kerf Taper angle (Degree) of Aluminum 6351 T6 material. Here, using garnet as an abrasive material. The approach was based on Full Factorial method and analysis of variance (ANOVA) and Regression Analysis to optimize the process parameters for effective machining. ANOVA was perfumed to obtain significant parameter impelling Taper Angle and Surface Roughness, which gives the percentage contribution of each process parameter under operating Condition. Abrasive mass flow rate is most Significant and Traveling Speed, standoff Distances are significant parameter in 0.20 mm and 0.25 mm Orifice Dia. The Regression analysis is used to evaluation the regression co-efficient that minimize the error and also predictions from the developed regression models were compared with measured Taper Angle (Degree) and Surface Roughness (µm) values.

Keyword: Abrasive water jet cutting, Full Factorial Design, ANOVA Analysis, Regression Analysis, Surface Roughness, Kerf Angle, aluminium alloy.

I. INTRODUCTION

Nowadays a number of methods and technologies designed for cutting of structural material exist. New requirements related to up-to-date material and its properties are constantly being laid on these methods. The development in this sphere has been reaching a rapid speed and composite or other heterogeneous materials have been achieving a remarkable prominence. [1]. Non-conventional machining utilizes other forms of energy .Composite materials have, despite their high market price, gained popularity in today's manufacturing of sophisticated products which have to be light and strong, in order to withstand loads in difficult environments. [2]. Abrasive water jet machining is a relatively new machining technique in that it makes use of the impact of abrasive material to erode the work piece material. It relies on the water to accelerate the abrasive material and deliver the abrasive to the work piece. In addition the water afterwards carries both the spent abrasive and the eroded material solid tool to cut the material usually by a shearing process. An abrasive water jet is a jet of water which contains abrasive material. Gokhan Aydin et al. investigation on Prediction of the Cut Depth of Granitic Rocks Machined by Abrasive Water jet (AWJ). The experimental data were used to assess the influence of AWJ operating variables on the cut depth. Using regression analysis, models for prediction of the cut depth from the operating variables and rock properties in AWJ machining of granitic rocks were then developed and verified. [3] Z heng Wang had an investigation on water jet machining for hardwood floors. A computer numeric control (CNC) router equipped with ultra-high pressure abrasive water jets was used to investigate the effects of wood species (density), pressure of water jet, feeding speed of wood samples and screen mesh grade of abrasives on the quality of hardwood floors. [4]. Izzet Kara Kurt et al investigation on the Depth of Cut of Granite in Abrasive Water jet Cutting. It is aimed at investigating the cut ability of granite by abrasive water jet. The effect of process parameters and the textural properties of granites on the cut depth and surface quality were investigated. [5] Zsolt Maros have worked on Taper cut at Abrasive Water Jet Cutting of an Aluminium alloy. Taper can be different at different materials and depends on the applied technological parameters (feed rate, pressure, abrasive flow rate etc.). [6]. S. Srinivas1 and N. Ramesh Babu had presents a set of studies performed on aluminum-silicon carbide particulate metal matrix composites prepared by adding 5, 10, 15 and 20% of SiC in aluminum alloy and processed with abrasive water jets that are formed with garnet and silicon carbide abrasives of 80 mesh size. These studies are essentially meant to assess the penetration ability of abrasive water jets on different compositions of Al-SiCp MMCs produced by stir casting method. [7]. M. Chithirai Pon Selvan et al had worked on Effects of process parameters on surface roughness in abrasive water jet cutting of aluminium. Surface roughness is one of the most important criteria, which help us determine how rough a work piece material is machined. As the jet pressure increases, surface becomes smoother. With increase in jet pressure, brittle abrasives break down into smaller ones. As a result of reduction of size of the abrasives the surface becomes smoother. It needs a large number of impacts per unit area under a certain pressure to overcome the bonding strength of any material with the increase in abrasive flow rate, surface roughness decreases. Traverse speed didn't show a prominent influence on surface roughness. Surface roughness increase with increase in standoff Distance. [8] The approach was based on Taguchi's method and analysis of variance (ANOVA) to optimize the AWJM process parameter for effective machining and to predict the optimal choice for each AWJM parameter such as pressure, standoff distance, Abrasive flow rate and Traverse rate. Main effects of MRR of each factor for various level conditions are shown in figure1. According to figure 1 the MRR increases with four major parameter Pressure, Stand of Distances, Traverse rate, Abrasive flow rate. Pressure is the most significant factor on MRR during AWJM. Meanwhile standoff distance, Abrasive flow rate and Traverse rate are sub significant in influencing. [9]. S. Ally et al. had investigation on Surface evolution models have been used in the past to accurately predict the cross-sectional profile of micro-channels resulting from the abrasive jet micro-machining (AJM) of glass and polymeric substrates [10]. Gokhan Aydin, et al. had an investigation on surface roughness of granite machined by abrasive water jet. Experimental design using Taguchi's method provides a simple, efficient and systematic approach for an optimal design of experiments to assess the performance, quality and cost. An increase in abrasive flow rate means a proportional increase in the cut depth. The water pressure and the abrasive flow rate were statistically found to be the most significant factor influencing the surface roughness of the granites, followed by the traverse speed and the stand-off distance with respect to the granite. [11] Farhad Kolahan et al have worked on Modeling and Optimization of Abrasive Water Jet Parameter using Regression Analysis. The process variables considered here include nozzle diameter, jet traverse rate, jet pressure and abrasive flow rate. Depth of cut, as one of the most important output characteristics. [12] Kerf angle, an important cutting performance measure, is a special geometrical feature inherent to AWJ machining and its high values are undesirable. Analysis of variance (ANOVA) was used to evaluate data obtained to determine the major significant process factors statistically affecting the kerf angle of the granites. [13] Taguchi's design of experiments and analysis of variance were used to determine the effect of machining parameters on Ra and TR. In case of hydraulic pressure, a higher hydraulic pressure increases the kinetic energy of the abrasive particles and enhances their capability for material removal. As a result, the surface roughness decreases. It is desirable to have a lower standoff distance which may produce a smoother surface due to increased kinetic energy. . In this case, a lower traverse rate is desirable to produce a better surface finish. [14] M. A. Azmir at el. had investigation on Effect of abrasive water jet machining parameters on aramid fiber reinforced plastics composite. Taguchi's design of experiment was used as the experimental approach. Through analysis of variance (ANOVA), it was found that the traverse rate was considered to be the most significant factor in both Ra and TR quality criteria. Ra and TR were reduced as increasing the hydraulic pressure and reducing the standoff distance and traverse rate. [15] Among the cutting parameters studied, kerf-taper compensation angle is found to have the most significant effect on the kerf taper and the kerf taper angle varies almost linearly with this compensation angle. It shows that with this technique, it is possible to achieve a zero kerf taper angle without compromising the nozzle traverse speed or cutting rate.

II. EXPERIMENTAL WORK

A. Material:

Although many studies investigating the cutting performances of water jets for several kinds of materials such as steel, brass, glass, or aluminium are available, there are few studies on Aluminium cutting in the literature. Aluminum's complex nature and the demands in the industries have led to investigations of the various machining and processing technologies to improve the productivity and reduce the costs. A work pieces of Aluminium 6351 T6 material is selected for parametric analysis of Abrasive Water Jet Machining. Silicon 0.417 %, Copper 0.061 %, Magnesium 0.513 %, Iron 0.144 %, Manganese 0.011 %, Nickel 0.004 %, Titanium 0.013 %, Aluminium 98.79 %.

B. Equipment:

All the experiments have been conducted on DWJ1525-FA Abrasive Water Jet Machine manufactured by Dardi International Corporation. The setup is used for machining of different material depends on different control parameters available in Machine. The main parts of the machine are: Electric Power Supply, Pressure Generating System (Pump), CNC Controller, Work table, Nozzle set up, Abrasive feeder.

Fig. 1 Abrasive water jet machining

Fig. 2 Surface Roughness Tester

Fig. 3 Vision measuring system.

Surface topography or surface roughness, also known as surface texture are terms used to express the general quality of a machined surface, which is concerned with the geometric irregularities and the quality of a surface . Surface roughness can be measured by surface roughness tester. Surface Roughness Tester from Mitutoyo, Model: SJ210 is a new generation of Surface Roughness Tester Series. It features high accuracy, wide application, simple operation, portability and stable performance. The tester is widely used in measuring the surface roughness of various metals and non-metals. Kerf geometry is a significant characteristic in abrasive water jet machining. Generally after a through cut using abrasive water jet a tapered slot will be produced with the top being wider than the bottom. The tapers of the machined surfaces were measured using Vision measuring system. Kerf taper is normally expressed by kerf taper angle

as = arctan(−) 2

wt is the top kerf width, wbis bottom kerf width, tn is workpiece thickness for through cuts.

C. Design of Experiment:

The Design of Experiments (DOE) is an efficient procedure for planning experiments so that the data obtained can be analyzed to yield valid and useful conclusions. Design of Experiments refers to the process of planning, designing and analyzing the experiment so that valid conclusions can be drawn effectively and efficiently. A full factorial design contains all possible combinations of a set of factors. This is

the most conservative design approach, but it is also the most costly in experimental resources. The full factorial designer supports both continuous factors and categorical factors with up to nine levels. In full factorial designs, you perform an experimental run at every combination of the factor levels. The analysis of variance is the statistical most commonly applied to the results of the experiment to determine the contribution of each factors. Study of ANOVA table for a given analysis helps to determine which of the factors need control and which do not. Once the optimum condition is determined, it is usually good practice to run a confirmation experiment. “The user of regression analysis attempts to discern the relationship between a dependent variable and one or more independent variables. That relationship will not be a functional relationship, however, nor can a cause-and-effect relationship necessarily be inferred”.

D. Experimental Parameter:

The Process Parameter like Stand of distance, impact angle, traverse rate, number of passes, abrasive material, abrasive particle size, abrasive shape, and abrasive mass flow rate, focusing tube diameter and focusing tube length water pressure orifice diameter etc. we have selected process parameter as Traverse rate (mm/min), Abrasive flow rate (gm/min) Standoff distance (mm) and Orifice diameter (mm) and analyze for Surface Roughness (m), Kerf Taper in AWJM.

E. Factors with levels value: - Orifice Dia. 0.20 mm and Orifice Dia. 025 mm

Table 1 Factors with levels value

No.	***Symbols***	***Machining Parameter***	***Level***			***Units***
			1	**2**	**3**	
1	A	Traverse Speed	50	55	60	mm/min
2	B	Abrasive mass flow rate	250	300	350	gm/mm
3	C	Standoff Distance	2	4	6	mm

Table 2 Fixed Parameter

Fixed Parameter	***Set Value***
Abrasive type	Garnet
Abrasive size	80Mesh(0.180mm)
Water flow rate	3.1 ltr/min
Nozzle diameter	0.76mm
Impact angle	90°

III. RESULT AND DISCUSSION

Sr. No	*Traverse Speed (mm/min)*	*Abrasive mass flow rate (gm/min)*	*Standoff distance (mm)*	*Taper Angle (Degree)*		*Surface Roughness (µm)*	
				0.20 mm Orifice Dia.	*0.25 mm Orifice Dia.*	*0.20 mm Orifice Dia.*	*0.25 mm Orifice Dia.*
1	50	250	2	0.889	1.551	3.059	3.158
2	60	250	2	1.019	1.752	3.604	3.220
3	55	350	4	0.599	1.112	2.229	2.921
4	55	300	4	0.801	1.366	2.503	3.071
5	55	350	2	0.798	1.091	2.208	2.862
6	50	300	2	0.428	1.251	2.305	2.991
7	50	250	6	0.945	1.622	3.25	3.177
8	60	250	6	1.167	1.799	3.752	3.240
9	50	350	2	0.428	0.952	2.068	2.780
10	55	350	6	0.655	1.131	2.239	2.930
11	60	350	4	0.659	1.210	2.252	2.940
12	55	250	6	0.982	1.711	3.521	3.200
13	60	300	6	0.855	1.501	2.989	3.125
14	60	300	4	0.812	1.461	2.656	3.113
15	50	300	4	0.729	1.292	2.379	3.052
16	50	250	4	0.899	1.591	3.153	3.169
17	55	250	2	0.959	1.642	3.345	3.180
18	55	300	2	0.798	1.351	2.441	3.065
19	50	350	6	0.532	1.058	2.107	2.857
20	55	250	4	0.979	1.651	3.46	3.190
21	60	350	2	0.658	1.189	2.248	2.934
22	60	300	2	0.809	1.421	2.566	3.113
23	50	300	6	0.739	1.321	2.434	3.060
24	50	350	4	0.518	0.998	2.069	2.801
25	60	350	6	0.689	1.244	2.292	2.950
26	60	250	4	1.089	1.761	3.634	3.230
27	55	300	6	0.809	1.391	2.512	3.098

F. Analysis of Variance (ANOVA)

In the analysis of variance (ANOVA), F-ratio was used to determine significant process factors. F-ratio is a tool to see which process factor has a significant effect on the Taper Angle and surface roughness of the aluminium 6351 T6 specimens. An F-ratio is calculated from the experimental results and then compared to the critical value. If the F-ratio calculated is larger than the F critical value, it is an indication that the statistical test is significant at the confidence level selected. If not, it indicates that the statistical test is not significant at the confidence level. In addition, larger F-ratio value indicates that there is considerable effect on the performance characteristic due to the variation of the process parameters. This analysis was carried out for the confidence level of 95%. Table 4 shows the result of ANOVA for machining outputs. It was found that among the factors B (Abrasive mass flow rate) is the most significant factor influencing the assessment of the surface roughness and Taper Angle responses. The control factors A (Traveling Speed), C (standoff distance) were found to be significant for the surface roughness and Taper Angle. The last column of table 4 indicates the percentage of each factor contribution (P) on the total variation, it is important to observe the P-values in the table. From the analysis of ANOVA, the factor B Abrasive mass flow rate (89.90 %) showed a most significant effect. It was followed by Traveling Speed A (07.50 %) and stand-off distance (01.21 %) for the Surface Roughness of 0.20 mm and 0.25 mm Orifice Dia. and other Responses of Taper Angle, the factor B Abrasive mass flow rate (88.63 %) Showed a most Significant parameter. It was followed by Traveling Speed A (17.61 %) and Standoff Distance C (02.02 %) is significant effect on machining.

Table 4 Results of analysis of variance (ANOVA) for the surface roughness and Taper angle of the Aluminium 6351 T6

Sample No.	*Source*	*Degree of Freedom*	*Sum of Squares*	*Mean Square*	*F-ratio*	*Contribution (%)*
Taper Angle (Degree) for 0.20 mm Orifice Dia.	A	2	0.1661	0.0830	15.96	17.61
	B	2	0.6543	0.3271	62.90	69.33
	C	2	0.0191	0.0095	01.82	02.02
	Error	20	0.1042	0.052	1	11.04
	Total	26	0.9437			100
Surface Roughness (µm) for 0.20 mm Orifice Dia.	A	2	0.5581	0.2790	33.214	06.92
	B	2	7.25	3.625	431.547	89.90
	C	2	0.087	0.0435	5.1785	01.17
	Error	20	0.1699	0.0084	1	02.10
	Total	26	8.065			100
Taper Angle (Degree) for 0.25 mm Orifice Dia.	A	2	0.16	0.080	200	09.80
	B	2	1.443	0.721	1803.75	88.63
	C	2	0.017	0.008	21.25	01.08
	Error	20	0.008	0.0004		00.49
	Total	26	1.628			100
Surface	A	2	0.037	0.0185	30.83	07.50

Roughness (µm) for 0.25 mm Orifice Dia.	B	2	0.438	0.219	365	88.84
	C	2	0.006	0.003	5	01.21
	Error	20	0.012	0.0006	1	02.43
	Total	26	0.493			100

G. Regression Analysis

As shown a total of 27 experiments were performed to gather the required data. In this table, the first three columns show the process parameters settings given by Full Factorial DOE matrix. The last four column is the measured process output resulted from different experiments. Different regression functions (linear, curvilinear, logarithmic, etc.) are fitted to the above data and the coefficients values are calculated using regression analysis. The best model is the most fitted function to the experimental data. Such a model can accurately represent the actual AWJ process. Therefore, in this research, the adequacies of various functions have been evaluated using analysis of variance (ANOVA) technique. The model adequacy checking includes test for significance of the regression model and test for significance on model coefficients. ANOVA results recommend that the quadratic model is statistically the best fit in this case. Statistical analysis show that the associated P-value for the model is lower than 0.05; i.e. α=0.05, or 95% confidence. This illustrates that the model is statistically significant. Based on ANOVA, the values of R2 and adjusted R2 are over 99% for h. This means that regression model provides an excellent explanation of the relationship between the independent variables and h response. Table 5 shows the values of "T-value"' and "P-Value" for each term on the performances of Surface Roughness (µm) and Taper Angle (Degree).

Table 5 Regression Co-efficient of Surface Roughness and Taper Angle

Sample No.	***Source***	***Coef.***	***SE Coef.***	***T***	***P***
Taper Angle (Degree) for 0.20 mm Orifice Dia.	Constant	0.843926	0.229674	3.6745	0.001
	A	0.018333	0.003613	5.0747	0.000
	B	-0.003769	0.000361	-10.4323	0.000
	C	0.016306	0.009032	1.8054	0.084
Surface Roughness (µm) for 0.20 mm Orifice Dia.	Constant	4.32683	0.491566	8.8021	0.000
	A	0.03521	0.007732	4.5538	0.000
	B	-0.01230	0.000773	- 15.9018	0.000
	C	0.03478	0.019330	1.7991	0.085
Taper Angle (Degree) for 0.25 mm Orifice Dia.	Constant	1.97993	0.0499529	39.6358	0.000
	A	0.01891	0.0007857	24.0678	0.000
	B	-0.00566	0.0000786	-72.0478	0.000
	C	0.01606	0.0019644	8.1734	0.000
Surface	Constant	3.44430	0.0806344	42.7150	0.000

Roughness (μm) for 0.25 mm Orifice Dia.	A	0.00911	0.0012684	7.1834	0.000
	B	-0.00310	0.0001268	-24.4324	0.000
	C	0.00928	0.0031709	2.9259	0.008

The Developed regression model of Taper angle and Surface Roughness for 0.20 mm Orifice Dia.

H. Regression Equation:

Taper Angle (Degree) = 0.843926 + 0.0183333 Traveling Speed - 0.00376889 Abrasive mass flow rate + 0.0163056 Standoff Distance …………………………….…… (1)

S = 0.0766369, R-Sq = 85.70%, R-Sq (adj) = 83.84%, PRESS = 0.186914, R-Sq (pred) = 80.21%

Surface Roughness (µm) = 4.32683 + 0.0352111 Traveling Speed - 0.0122956 Abrasive mass

flow rate + 0.0347778 Standoff Distance ………………………... (2)

S = 0.164024, R-Sq = 92.33%, R-Sq (adj) = 91.33%, PRESS = 0.826831,

R-Sq (pred) = 89.75%

The Developed regression model of Taper angle and Surface Roughness for 0.25 mm Orifice Dia. Taper Angle (Degree) = 1.97993 + 0.0189111 Traveling Speed - 0.00566111 Abrasive mass

flow rate + 0.0160556 Standoff Distances ……………………..……… (3)

S =R-Sq =R-Sq (adj) =PRESS = 0.0166681, 99.61%, 99.56%, 0.00891774,

R-Sq (pred) = 99.45%

Surface Roughness (µm) = 3.4443 + 0.00911111 Traveling Speed - 0.00309889 Abrasive mass flow rate + 0.00927778 Standoff Distances ………………………… (4)

S = 0.0269058 R-Sq = 96.62% R-Sq (adj) = 96.18% PRESS = 0.0230253

R-Sq (pred) = 95.32%

The kerf angle increases with an increase in nozzle traverse speed and this is also observed in graph plot in fig. 4. This is because an increase in traverse speed has a large effect on the required jet energy for material removal deriving from a reduction in jet exposure time. An increase in the traverse speed may be associated with a decrease in the jet interaction on a given area of material, which leads to material erosion by fewer abrasive particles. Cutting at a low traverse speed is, therefore, associated with small kerf angles. Additionally, although a decrease in traverse speed will practically increase the production time, lower speed is always favorable in achieving small kerf angles. It is anticipated that with higher mass flow rate which means more number of abrasive particles on unit area to remove more materials throughout the width and produce a smaller kerf angles and that is the reason in Fig. 5 taper angle decreases with increase in flow rate. It was stated in the study that a critical energy transfer from the jet to the particles was needed to fracture the material On the other hand, an increase in the abrasive flow rate is associated with an increase in the process costs as well. From fig. 6, the kerf angle increases with an increase in standoff distance. This phenomenon may be explained by jet divergence. When the jet penetrates into the work piece, it begins to lose its kinetic energy. The diverged jet, thereby, doesn't have sufficient energy for effectively cutting as it approaches the lower part of the kerf. That means, the kerf angle increases with the increasing of the standoff distance.

Fig. 4 Taper Angle v/s Traveling Speed

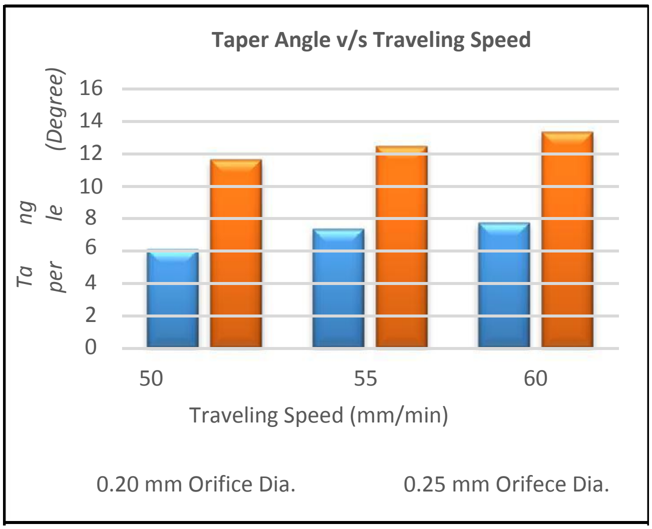


Fig. 5 Taper Angle v/s Abrasive mass flow rate

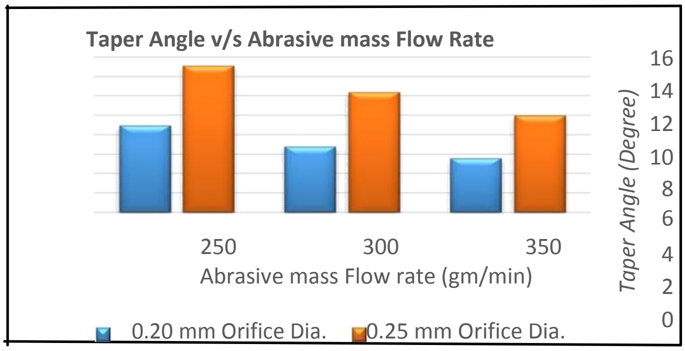


Fig. 6 Taper Angle v/s Standoff Distances

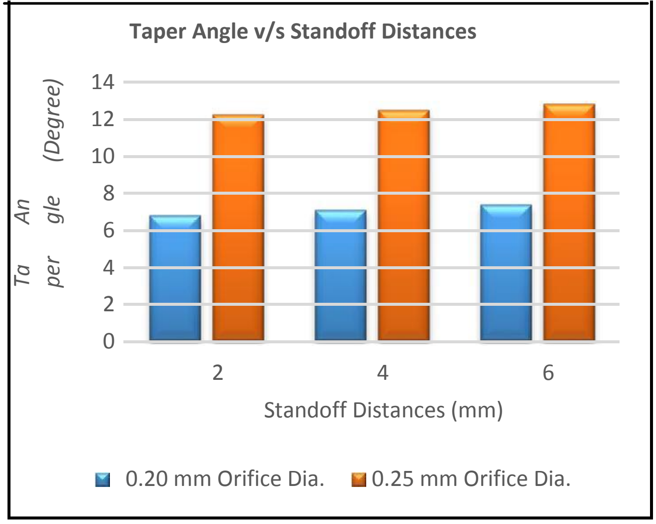
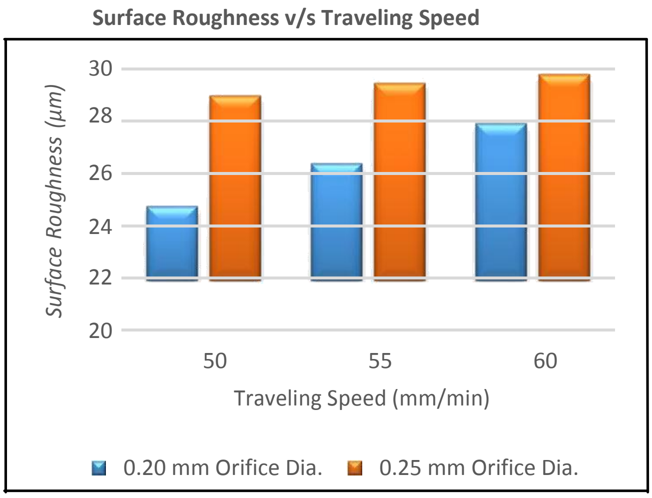


Fig. 7 Surface Roughness v/s Traveling Speed



Traverse speed didn't show a prominent influence on surface roughness. For decreasing of the machining costs every user try to choose the feed rate of the cutting head as high as possible, but increasing the traverse speed always causes increasing of inaccuracy and surface roughness. But with increase in work feed rate the surface roughness increased and that's see in Fig. 7 This is due to the fact that as the work moves faster, less number of particles are available that pass through a unit area. Therefore, less number of impacts and cutting edges are available per unit area, which results a rougher surface. It needs a large number of impacts per unit area under a certain pressure to overcome the bonding strength of any material. With the increase in abrasive flow rate, surface roughness decreases as shown in Fig.8. This is because of more number of impacts and cutting edges available per unit area with a higher abrasive flow rate. Abrasive flow rate determines the number of impacting abrasive particles as well as total kinetic energy available. Therefore, higher abrasive flow rate, higher should be the cutting ability of the jet. But for higher abrasive flow rate, abrasives collide among themselves and lose their kinetic energy. It is evident that the surface is smoother near the jet entrance and gradually the surface roughness increases towards the jet exit. Surface roughness increase with increase in standoff distance. Generally, higher standoff distance allows the jet to expand before impingement which may increase vulnerability to external drag from the surrounding environment. Therefore, increase in the standoff distance results an increased jet diameter as cutting is initiated and in turn, reduces the kinetic energy of the jet at impingement. So surface roughness increase with increase in standoff distance as shown in Fig. 9. It is desirable to have a lower standoff distance which may produce a smoother surface due to increased kinetic energy. The machined surface is smoother near the top of the surface and becomes rougher at greater depths from the top surface.

Fig. 8 Surface Roughness v/s Abrasive mass flow rate

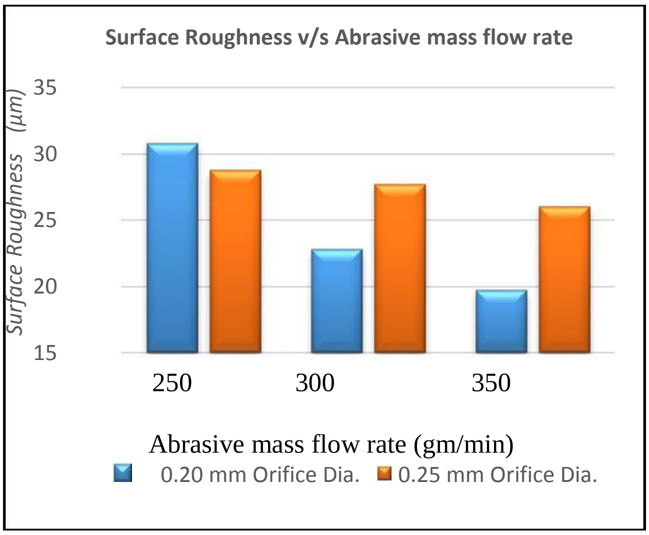
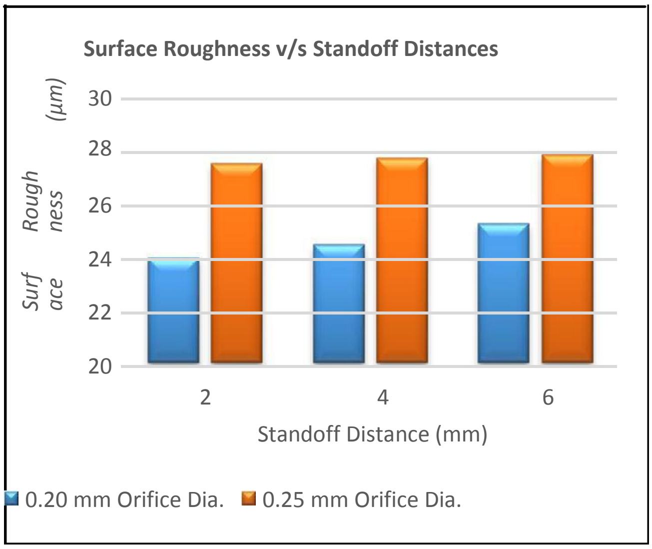


Fig. 9 Surface Roughness v/s Standoff Distances



IV. CONCLUSION

In present study parametric analysis has been carried out for Taper Angle and Surface roughness on Aluminium 6351 T6 Material. Experiments are carried out using Full Factorial by varying Traverse speed, Abrasive mass flow rate, Stand of distance and Orifice Diameter for Aluminium 6351 T6 material. Minitab 16 software was used for analyze the experimental data. Following conclusions have been drawn after analysis.

- Process parameters do not have same effect for every response. Significant parameters and its percentage contribution changes as per the behavior of the parameter with objective response.
- Surface roughness constantly decreases as Abrasive mass flow rate increases. It is recommended to use more Abrasive mass flow rate to decrease surface roughness. Among the process parameters considered in this study Abrasive mass flow rate have most Significant Parameter on surface roughness.
- As nozzle traveling speed increase, surface roughness increases. This means that low traverse speed should be used to have more surface smoothness but is at the cost of sacrificing productivity.
- This experimental study has resulted surface Roughness increase as standoff distance increase. Therefore, to achieve an overall cutting performance, low standoff distance should be selected. In this study Standoff Distances have significant Parameter on Surface Roughness.
- Kerf Angle decreases as Abrasive mass flow rate increases. Among the process parameters considered in this study Abrasive mass flow rate have most Significant Parameter on Kerf Angle.
- As nozzle traveling speed increase. Kerf Angle increases. In this study Traveling Speed have significant Parameter on Kerf Angle.
- This experimental Show has resulted Kerf Angle increase as standoff distance increase. Standoff Distance have significant Parameter on Kerf Angle.
- Mixing ratio is a most significant control factor for Kerf Angle and Surface Roughness.

REFERANCES

[1] P. Hreha, S. hloch, P. Monka, K. Monková "Investigation OF Sandwich Material Surface Created by Abrasive Water Jet (AWJ) via Vibration Emission" METABK 53(1) 29-32 (2014)
[2] A. Alberdi, A. Suárez, T. Artaza, G. A. Escobar-Palafox, K. Ridgway "Composite Cutting with Abrasive Water Jet" Procedia Engineering 63 (2013) 421 – 429.
[3] Gokhan Aydin, Izzet Karakurt,Kerim Aydiner "Prediction of the Cut Depth of Granitic Rocks Machined by Abrasive Water jet (AWJ)" Rock Mech. Rock Engg. (2013) 46:1223– 1235
[4] Z heng Wang "An investigation on water jet machining for hardwood floors" Eur. J. Wood Prod. (2012) 70:55–59
[5] Izzet Kara Kurt, Gokhan Aydin, and Kerim Aydiner "An Experimental Study on the Depth of Cut of Granite in Abrasive Water jet Cutting" Materials and Manufacturing Processes, 27: 538–544, 2012
[6] Zsolt Maros "Taper of cut at abrasive water jet cutting of an Aluminium alloy" Journal of Production Processes and Systems, vol. 6. (2012) No. 1. pp. 55-60.
[7] S. Srinivas and N. Ramesh Babu "Penetration Ability of Abrasive Water Jets in Cutting of aluminum-silicon carbide particulate metal matrix Composites" Machining Science and Technology, 16:337–354 (2012) Taylor & Francis.
[8] M. Chithirai pon selvan, N. Mohana sundara Raju, H. K. Sachidananda "Effects of process parameters on surface roughness in abrasive water jet cutting of aluminium" Front. Mech. Eng. 2012, 7(4): 439–444
[9] Leeladhar Nagdeve, Vedansh Chaturvedi & Jyoti vimal "Implementation of Taguchi Approach for Optimization of Abrasive Water Jet Machining Process Parameters" International Journal of Instrumentation, Control and Automation (IJICA) ISSN: 2231-1890, Vol-1 Iss-3,4, 2012
[10] S. Ally, J.K.Spelt , M.Papini "Prediction of machined surface evolution in the abrasive jet micro-machining of metals" Wear 292–293 (2012) 89–99
[11] Gokhan aydin, Izzet karakurt and Kerim aydiner "An investigation on surface roughness of granite machined by abrasive water jet" Bull. Mater. Sci., Vol. 34, No. 4, July 2011, pp. 985–992.
[12] Farhad Kolahan, A. Hamid Khajavi " Modeling and Optimization of Abrasive Water jet Parameters using Regression Analysis" International Journal of Aerospace and Mechanical Engineering 5:4 2011
[13] Izzet Kara Kurt, Gokhan Aydin & Kerim Aydiner "Analysis of the kerf angle of the granite machined by abrasive water jet (AWJ)" Indian Journal of Engineering & Materials Sciences Vol. 18, December 2011, pp. 435-442
[14] M.A. Azmir, A.K. Ahsan "A study of abrasive water jet machining process on glass/epoxy composite laminate" Journal of Materials Processing Technology 209 (2009) 6168–6173.
[15] M. A. Azmir & A. K. Ahsan & A. Rahmah "Effect of abrasive water jet machining parameters on aramid fiber reinforced plastics composite" Int. J Mater Form (2009) 2:37– 44