Investigate the effect of various process parameters of Abrasive water jet machine for Aluminum 6061

Parth P. Pandya[1], Prof. Uchit J. Patel[2]

[1]Student, M.Tech Cad/Cam, U. V. Patel College of Engineering, GANPAT University, Kherwa, Gujarat, India
[2]Assistant Professor, Mechanical Engineering, U. V. Patel College of Engineering, GANPAT University, Kherwa, Gujarat, India

---

Abstract - Manufacturing industry is becoming ever more time conscious with regard to the global economy. The need for rapid prototyping and small production batches is increasing in modern industries. These trends have placed a premium on the use of new and advanced technologies for quickly processing raw materials into usable goods; with no time being required for tooling. The idea of machining with Water jet (WJ) is adopted from nature that has been showing phenomena of erosion of hardest of the rock by a narrow stream of water. The rate of erosion is observed to be faster when the sand particles is mixed with stream of water and that has lead to the development of AWJ technology.

Key Words: Abrasive water jet, Process parameters, kerf, Surface roughness, MRR.

1. INTRODUCTION

Abrasive water jet machining (AWJM) is a well-established non-traditional machining method used for cutting difficult-to machine materials. This method is especially} appropriate for very soft, brittle and fibrous materials. It's a non-traditional machining method while not abundant heat generation and therefore the machined surface is nearly with none heat affected zone or residual stress. differing types of abrasives area unit utilized in AWJM like mineral, olivine, Al oxide (Al2O3), silica-sand, glass bead, carbide (SiC), zirconium, etc. however a survey shows that ninetieth of the AWJM is completed using garnet [1]. The pure mathematics cut by the abrasive water jet is characterized by the highest breadth of the cut, bottom breadth of the cut, initial broken breadth, initial broken depth, etc. Effort ought to incline to reduce these parameters. The cut pure mathematics depends on the kind of abrasives and cutting parameters like abrasive jet pressure, standoff distance (SOD) of the nozzle from the target, work feed rate, abrasive mass flow rate, etc. Efforts are created to enhance the cutting performance of the abrasive water jet.

1.1 EXPERIMENTAL PROCEDURE

KMT abrasive water jet machine utilized in the experimentations. The jet line JL- 150 radical air mass pump is employed in industries. And having pressure of machine is 3500 bar. The machine furnished with a magnitude feed type of abrasive hopper, an abrasive feeder arrangement, pneumatic controlling valve and dimension of work piece table is 3000 x 3000 millimeter. Orifice used to convert the high pressure water into collimated jet, with the facilitate of carbide nozzle to from an abrasive water jet. Throughout the experiments the nozzle was tested and switched noticeably if the nozzle wiped out.

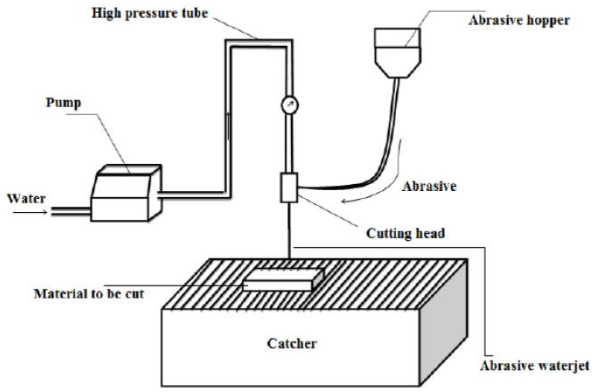

Figure no. 1 Abrasive water jet machine

The abrasive passes to mixture chamber mistreatment compressed air. Rubbish of fabric and abrasives were collected into the catcher tank. Several laborious materials is simply cut by abrasive water jet machine and here Al 6061 will be use as a check material. Several abrasive materials are utilized in abrasive water jet cutting machine like silicon oxide, garnet, Al oxides, carbide etc. we are going to use garnet materials as an abrasive. And also the materials can cut by this abrasives and hence the result are investigated. Normal 120 mesh grit size are choose for experiment. Work piece size is 60×40×12 mm. Input parameters are Traverse speed, Abrasive flow rate, Stand-off distance. And the output parameters are MRR, Surface roughness, and Kerf width ratio.

1.2 EXPERIMENTAL PROCEDURAL

KMT abrasive water jet machine utilized in the experimentations. The jet line JL- 150 radical air mass pump is employed in industries. And having pressure of machine is 3500 bar. The machine furnished with a magnitude feed type of abrasive hopper, an abrasive feeder arrangement, pneumatic controlling valve and dimension of workpiece table is 3000 x 3000 millimeter. Orifice used to convert the high pressure water into collimated jet, with the facilitate of carbide nozzle to from an abrasive water jet. Throughout the experiments the nozzle was tested and switched noticeably if the nozzle wiped out. The abrasive passes to mixture chamber mistreatment compressed air. Rubbish of fabric and abrasives were collected into the catcher tank. Several laborious materials is simply cut by abrasive water jet machine and here Al 6061 will be use as a check material. Several abrasive materials are utilized in abrasive water jet cutting machine like silicon oxide, garnet, Al oxides, carbide etc. we are going to use garnet materials as an abrasive. And also the materials can cut by this abrasives and hence the result are investigated. Normal 120 mesh grit size are choose for experiment. Work piece size is 60×40×12 mm. Input parameters are Traverse speed, Abrasive flow rate, Stand-off distance. And the output parameters are MRR, Surface roughness, and Kerf width ratio.

2. PROCESS PARAMETER AND DESIGN

Table no. 1 Factors and levels

Symbol	Input Parameters	Level 1	Level 2	Level 3
A	Traverse speed (mm)	50	100	150
B	Abrasive flow rate (g/min)	250	300	350
C	Stand-off distance (mm)	2	3	4

For this 3 factors 3 level Taguchi L9 orthogonal method is used for experiment design. And the experimental results are discussed. This factors has been selected to see the effect of traverse speed on machining while other parameter are comparatively less. The most impact making and valuable parameters are chosen for analysis. Such as MRR, Surface roughness and kerf width ratio. MRR value is suitable high and surface roughness value is better when it is less. Kerf width ratio also should be minimum for optimum result. For output result measurement MRR the traditional method is used. MRR equals to weight before machining – weight after machining. And divide the value by machining time taken by work piece. The surface roughness value is measured by Taylor Hobson surtronic S100 surface roughness tester. Kerf width ratio is average value of top kerf width and bottom kerf width of the work piece.

3. RESULT & DISCUSSSION

3.1 Effect of different process parameter on MRR

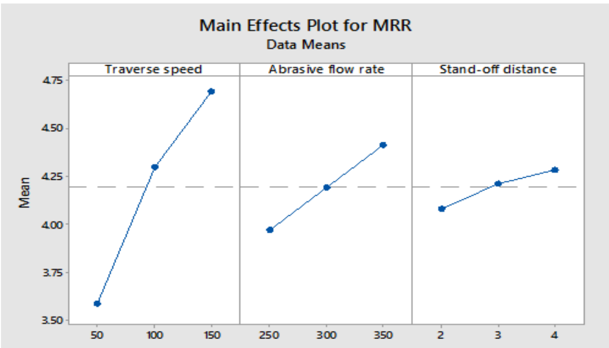

Figure no.2 Main effect plot for MRR

Traverse speed is that the most authoritative the material removal rate method. It's conjointly expected to be as a result of if the speed is rises clearly cutting head travel a lot of distance in less time. Thus, the first input parameter provides most impact. Expect that it's clearly evident that the other factor doesn't influence very much like compared to traverse speed. Throughout 50 to a 100 traverse speed MRR has augmented significantly. Abrasive rate of flow has conjointly created a sway on MRR. It's clearly visible in graph that the MRR growths with growing in rate of flow. From 250 to three hundred and until350 rate of flow MRR has perpetually augmented. Because, the high molecule interaction between abrasive particles and material. SOD has least contributed parameter in MRR method, however MRR bit by bit increase with rises in SOD. Since focus space is a lot of on material.

3.2 Effect of different process parameter on Surface roughness

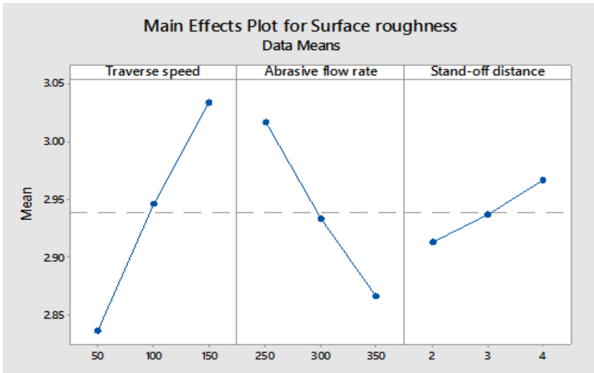

Figure no. 3 Main effect plot for SR

Traverse speed is more vital parameter in surface roughness. But, now it offers adverse impact on material roughness. At lowest speed it offers quality texture. And at higher speed it offers rough surface texture. So, for worthy and sleek SR 50 mm/min is optimum speed for this combination of parameter.

Abrasive rate has conjointly contributed in well manner during this method. Surface roughness reduces with larger flow. More the flow additional the nice surface texture. So, optimum worth is 350 gm/min for SR. Nozzle tip distance additionally offers significant results. It's expected that once the SOD will decrease the roughness of surface will also decrease. Because, once nozzle is near to object the flow of abrasive are going to be focused on explicit region. So, it will take away most material. SO, for tip distance 2 millimeter is optimum parameter for SR.

3.3 Effect of different process parameter on Kerf width ratio

Kerf dimension depends mostly on 2 factors speed and nozzle tip distance. If the nozzle tip distance raised the width of cut goes to rise because of a lot of area are coated by its flow distribution. Throughout a pair of to 3 mm the taper width raised the foremost. at the moment it declines a bit however offers negative result as well. Thus at 2mm the kerf width is flawless. Flow rate makes optimistic impact on method. Higher flow ends up in less width of cut. As a result of a lot of particles can take away more quantity of material. If the flow growths it diminishes dimension of kerf by its erosion action. Graph remains steady throughout 250 to 350 and at the moment downfall started in flow result on kerf dimension.

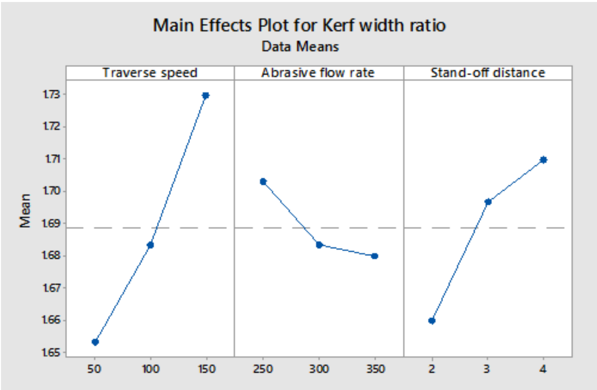

Figure no. 4 Main effect plot for Kerf width ratio

350 flow is perfect. Travelling speed of cutting head primary reason for the kerf width. It tends to indicate rise once the speed is raised. It shows extreme escalation throughout 100 to 150. If the speed is higher than the abrasive particle passes quickly and generates taper section deep down. So, because of high traverse speed bottom taper dimension decreases. 50mm/min speed is most well-liked for less taper cut.

4. CONCLUSION

From the above discussions it can be concluded that the if the traverse speed is kept high while the pressure is fixed and. At that time the effect of traverse speed is significantly increase. For optimal surface roughness the low traverse speed suitable. If the traverse speed is high than it will not generate smooth texture. Abrasive flow rate gives positive results in this process till 350. After that it's effect can be changed. Because very much amount of flow rate can leads higher molecule friction with material's particle, so it can be stuck on surface area. And it causes increase in roughness. MRR can be also affected negatively after some extend. Stand-off distance independent performance can be measured while the nozzle tip distance is kept very high but it will causes rough surface and more kerf width ratio. It can improve the MRR rate.

REFERENCES

[1]Azmir, M. A., and A. K. Ahsan. "A study of abrasive water jet machining process on glass/epoxy composite laminate." Journal of Materials Processing Technology 209.20 (2009): 6168-6173.

[2]Khan, Ahsan Ali, and M. M. Haque. "Performance of different abrasive materials during abrasive water jet machining of glass." Journal of materials processing technology 191.1 (2007): 404-407.

[3] Akkurt, Adnan, et al. "Effect of feed rate on surface roughness in abrasive waterjet cutting applications." Journal of Materials Processing Technology 147.3 (2004): 389-396.

[4] Begic-Hajdarevic, Derzija, et al. "Experimental Study on Surface Roughness in Abrasive Water Jet Cutting." Procedia Engineering 100 (2015): 394-399.

[5]Cosansu, Gulay, and Can Cogun. "An investigation on use of colemanite powder as abrasive in abrasive waterjet cutting (AWJC)." Journal of mechanical science and technology 26.8 (2012): 2371-2380.

[6]K.S. Jai Aultrin, M. Dev Anand (2014) "Optimization of Machining Parameters in AWJM Process for an Copper Iron Alloy Using RSM and Regression Analysis" International Journal of Emerging Engineering Research and Technology

[7]K. Arun Kumar et. al.(2016) "Process parameter effect on surface finish in abrasive water jet machining-a review" International Journal of Machine Tools and Manufacture 88 (2016): 108-117.

[8]Sudhakar R. Lohar et. Al (2017) "Investigation of Effect of Abrasive Water Jet Machining Process Parameters on Performance Characteristics of High Carbon High Chromium Steel" Journal of Materials Processing Technology

[9]Kamlesh Kadia et al.(2014) "Investigation of Process Parameters on Improvement of MRR and Surface Roughness on Abrasive Water Jet Machine for Inconel 600"