International Journal of Engineering Research & Management Technology

May- 2015 Volume 2, Issue-3
ISSN: 2348-4039
Email: editor@ijermt.org www.ijermt.org

"Sharpening Skills..... Serving Nation"

Special Issue: 2nd International Conference on Advanced Developments in Engineering and Technology
Held at Lord Krishna College of Engineering Ghaziabad, India

Study of Effect of Process Parameters on Abrasive Jet Machining

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ABSTRACT-
As the world is advancing forth technically in the field of space research, missile and nuclear industry; very complicated and precise components having some special requirements are demanded by these industries. The conventional methods, in spite of recent advancements are inadequate to machine such materials from stand point of accuracy, precision and economic production. The metal like hast alloy, Nitra alloy, nimonics and many harder to machine material are such that they can't be machined by conventional methods but require some special techniques. Abrasive jet machine (AJM) removes material through the action of focused beam of abrasive laden gas. Micro -abrasive particles are propelled by an inert gas of velocity. When directed at a work piece, the resulting erosion can be used for cutting, etching, drilling, polishing and cleaning. In this paper testing and analyze various process parameters of abrasive jet machining is presented

Keywords -Abrasive jet machining, Erosion rate, Glass

I. INTRODUCTION

Abrasive machining is a machining process where material is removed from a work piece using a multitude of small abrasive particles. Common examples include grinding, honing, and polishing. Abrasive processes are usually expensive, but capable of tighter tolerances and better surface finish than other machining processes chances, delectability, costs and safety aspect etc.) The literature study of Abrasive Jet Machining [1-7] reveals that the Machining process was started a few decades ago. Till date there has been a through and detailed experiment and theoretical study on the process. Most of the studies argue over the hydrodynamic characteristics of abrasive jets, hence ascertaining the influence of all operational variables on the process effectiveness including abrasive type, size and concentration, impact speed and angle of impingement. Other papers found new problems concerning carrier gas typologies, nozzle shape, size and wear, jet velocity and pressure, standoff distance (SOD) or nozzle tip distance (NTD). These papers express the overall process performance in terms of material removal rate, geometrical tolerances and surface finishing of work pieces, as well as in terms of nozzle wear rate. Finally, there are several significant and important papers which focus on either leading process mechanisms in machining of both ductile and brittle materials, or on the development of systematic experimental statistical approaches and artificial neural networks to predict the relationship between the settings of operational variables and the machining rate and accuracy in surface finishing. In recent years abrasive jet machining has been gaining increasing acceptability for deburring applications.

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AJM deburring has the advantage over manual deburring method that generates edge radius automatically. This increases the quality of the deburred components. The process of removal of burr and the generation of a convex edge were found to vary as a function of the parameters jet height and impingement angle, with a fixed SOD. The influence of other parameters, viz. nozzle pressure, mixing ratio and abrasive size are insignificant. The SOD was found to be the most influential factor on the size of the radius generated at the edges. The size of the edge radius generated was found to be limited to the burr root thickness.

Abrasive jet finishing combined with grinding gives rise to a precision finishing process called the integration manufacturing technology, in which slurry of abrasive and liquid solvent is injected to grinding zone between grinding wheel and work surface under no radial feed condition. The abrasive particles are driven and energized by the rotating grinding wheel and liquid hydrodynamic pressure and increased slurry speed between grinding wheel and work surface achieves micro removal finishing Abrasive water jet machines are becoming more widely used in mechanical machining. These machines offer great advantages in machining complex geometrical parts in almost any material. This ability to machine hard materials, combined with advancements in both the hardware and software used in water jet machining has caused the technology to spread and become more widely used in industry. New developments in high pressure pumps provide more hydraulic power at the cutting head, significantly increasing the cutting performance of the machine. Analysis of the economic and technical has been done by researchers. Those technology advancements in applying higher power machining and intelligent software control have

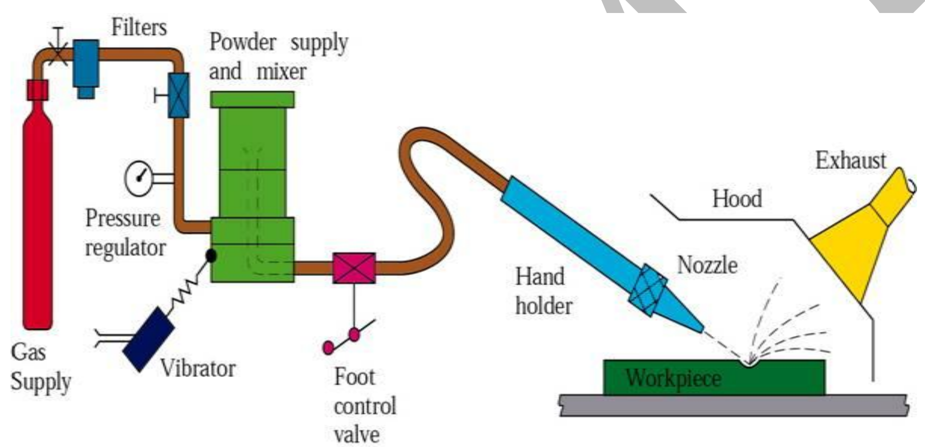

Fig 1 Layout of AJM

TABLE 1

Abrasive jet machine characteristics

S.No.	**Process Parameter**
1	Carrier gas
2	Nozzle tip distance
3	Type of abrasive
4	Size of abrasive grains
5	Velocity of abrasive jet

6	Mixing ratio
7	Work material
8	Nozzle design
9	Shape of cut

TABLE 2

Various Process Parameters of AJM

Mechanics of metal removal	Brittle fracture by impinging abrasive grains at high speed.
Carrier gas	Air , carbon -dioxide
Abrasives	Alumina , SiC
Pressure	2-10 atm
Nozzle	WC, sapphire,
Critical parameters	Abrasive flow rate and velocity, nozzle tip distance abrasive grain size
Material application	Hard and brittle metals ,alloys, and non metallic

II Experimental Work

Experiments were conducted to confirm the validity of my results as well as the results found in Roopa Rani and S.Seshan experimental work. The experimental work was carried on a test rig which was manufactured in the workshops of ITM University, Gurgaon, and Haryana, India. The abrasive grits (alumina) were mixed with air stream ahead of nozzle and the abrasive flow rate was kept constant throughout the machining process. The jet nozzle was made of tool steel to carry high wear resistance. Drilling of glass sheets was conducted by setting the test rig on the parameters listed in Table3

TABLE 3

Abrasive Jet Machining Experimental Parameters

S.No.	AJM Parameter	Condition
1	Types of Abrasive	alumina
2	Abrasive Size	0.15-1.25 mm
3	Jet Pressure	5.5-7.5 kg/cm^2
4	Nozzle tip distance	6-8mm

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Glass was used as a work piece material because of its homogeneous properties. The test specimens were cut into square and rectangular shape for machining on AJM unit having thickness 3mm, 4mm, 5mm, 6mm and 8mm. In machine the initial weights of glass specimens were measured with the help of digital balance. After machining the final weights were measured with the help of digital balance to calculate the material removal rate. In our machine the movement to specimens in x-y directions is provided with the help of cross slide and in z direction with help of worm and worm wheel drive. First the abrasive that was alumina in powder form was fed in the hopper carefully. After that compressor connections were checked.

The glass specimen was properly clamped on cross slide with the help of various clamps. As the compressor was switched on, the hopper gate valve was opened so that abrasive grains were mixed with air jet coming from the compressor and focused on the specimen with help of nozzle. Different readings were taken using different process parameters on the glass specimens of different thickness and all results were tabulated. All results were compared with the theoretical results also to check the validity of our results

III RESULTS

A. Experimental Results

Table 4 shows the relationship between nozzle tip distance and diameter of hole at a set pressure of 5.5 kg/ cm^2

Table 4

Relationship between nozzle tip distance and diameter ofhole at a set pressure of 5.5 kg/ cm^2

S.No	Nozzle tip distance (mm)	Top surface diameter (mm)	Bottom surface diameter (mm)
1	6	7.05	4.51
2	12	8.72	5.05
3	15	11.21	5.33
4	18	6.65	6.65

Table 5 shows the relationship between nozzle tip distance and diameter of hole at a set pressure6.5 kg/ cm^2

Table 5

Relationship between nozzle tip distance and diameter ofhole at a set pressure 6.5 kg/ cm^2

S.No	Nozzle tip distance (mm)	Top surface diameter (mm)	Bottom surface diameter (mm)
1	6	7.55	4.55
2	12	8.97	5.65
3	15	11.15	5.91
4	18	11.75	6.05

Table 6 shows the relationship between nozzle tip distance and diameter of hole at a set pressure 8 kg/ cm^2

Table 6

Relationship between nozzle tip distance and diameter of hole at a set pressure8 kg/ cm^2

S.No	Nozzle tip distance (mm)	Top surface diameter (mm)	Bottom surface diameter (mm)
1	6	7.72	5.05
2	12	9.95	5.75
3	15	11.45	5.96
4	18	11.81	6.75

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Table 7 shows the Relationship between pressure and material removal rate (MRR) at thickness 8 mm and NTD 12 mm

Table7

Relationship between pressure and material removal rate (MRR) at thickness 8 mm and NTD 12 mm

S.No	Pressure(kg/cm^{2})	Initial weight (gm)	Final weight(gm)	Time(sec)	MRR(mg/min)
1	5.5	140.190	140.50	20	120
2	6.5	161.13	161.13	20	210
3	7.5	137.53	137.37	20	400

Table 8 shows the Relationship between pressure and material removal rate (MRR) at thickness 12 mm and NTD 12 mm

Table 8

Relationship between pressure and material removal rate (MRR) at thickness 12 mm and NTD 12 mm

S.No	Pressure(kg/cm^{2})	Initial weight (gm)	Final weight(gm)	Time(sec)	MRR(mg/min)
1	5.5	206.6	206.57	20	90
2	6.5	207.13	207.05	20	213
3	7.5	201.75	201.75	20	480

B. Theoretical Results

Results of experimental work by Roopa Rani and S.Seshan.. They have conducted some experiments on AJM test rig. At department of mechanical engineering, Indian institute of science, Bangalore.

Table 9 shows the effect of pressure on material removal rate (MRR)

Table 9

Effect of pressure on material removal rate (MRR)

S.No.	Gas pressure	Materials removal rate (mg/min)
1	5	18
2	6	21
3	7	23
4	8	26

Table 10 shows the effect of nozzle tip distance (NTD) on diameter of hole

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Table 10

Effect of Nozzle tip diameter (NTD) on diameter of hole

S.No	Nozzle tip distance (mm)	Diameter of hole (mm)
1	0.79	0.46
2	5.00	0.64
3	10.01	1.50
4	14.99	2.01

IV CONCLUSION

This paper presents various results of experiments have been conducted by changing pressure, nozzle tip distance on different thickness of glass plates. The effect of their process parameters on the material removal rate (MRR), top surface diameter and bottom surface diameter of hole obtained were measured and plotted. These were compared with the Roopa Rani and S.Seshan results [7]. It was observed that as nozzle tip distance increases, the top surface diameter and bottom surface diameter of hole increases as it is in the general observation in the abrasive jet machining process. As the pressure increases material removal rate (MRR) is also increased.

REFERENCES

1. Ghobeity, A.; Spelt, J. K.; Papini Abrasive jet micro machining of planar areas and transitional slopes ,M.Publication: Journal of Micromechanics and Microengineering, Volume 18, Issue 5, pp. 055014.Publication Date: 01/ 05/2008
2. M. Wakuda, Y. Yamauchi and S. Kanzaki "Effect of work piece properties on machinability inabrasive jet machining of ceramic materials", Publication:Precision Engineering, Volume 26, Issue 2, April 2002,Pages 193-198
3. R. Balasubramaniam, J. Krishnan and N.Ramakrishnan , "An experimental study on the abrasive jet deburring of cross drilled holes" , Publication: Journal of Materials Processing Technology, Volume 91, Issues 1-3, 30 June 1999, Pages 178-182
4. R. Balasubramaniam, J. Krishnan and N. Ramakrishnan "A study on the shape of the surfacegenerated by abrasive jet machining", Publication: Journal of Materials Processing Technology, Volume 121, Issue 1, 14February 2002, Pages 102-106
5. M. K. Muju and A. K. Pathak "Abrasive jet machining of glass at low temperature", Publication: Journal of Mechanical Working Technology, Volume 17, August 1988, Pages 325-332
6. A. P. Verma and G. K. Lal Publication "An experimental study of abrasive jet machining",International Journal of Machine Tool Design and Research, Volume 24, Issue 1, 1984, Pages 19-29
7. M. Roopa Rani & S. Seshan "AJM - ProceesVariables And Current Applications", Publication-Journal of Metals Materials& Process,1995 Vol.7 No. 4 PP.279-290
8. A.EI-Domiaty, H.M.Abd EI -Hafez, and M.A. Shaker "Drilling of glass sheets by abrasive jet machining", World Academy of Science, Engineering and Technology 56,2009.

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