IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

PARAMETRIC STUDIES AND EFFECT ON PNEUMATIC JET MACHINING

Dr. Raju N.Panchal [1], Anant D.Awasare [2], Vahid M.Jamadar [3]

[1]Professor, Mechanical Engg. Dept, AGTI's DACOE Karad,(India)

[2] Assistant Professor, Mechanical Engg. Dept, AGTI's DACOE Karad, (India)

ABSTRACT

In recent years some non-traditional of manufacturing have been invented .In order to supplement affectivity the machining problems of hard to machine and brittle materials. Once of these non- traditional techniques is Pneumatic Jet machining. The pneumatic jet machining can be suitable employed for machining super alloys and refractory type material. The process is also very much suitable for cutting, grooving, cleaning, finishing and deburring operations of hard and brittle materials like germanium, glass, ceramics and mica.

Keywords—Non-traditional, Brittle material, Super alloys

I. INTRODUCTION

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. This challenge is taken by new development taking place in the manufacturing field. The most basic requirements of future manufacturing technology are:

1. Sustained productivity in the face of rising strength barrier.

2. Higher accuracy consistent with increasing demand for higher tolerance.

The Abrasive Jet Machining (AJM) is considered as an attractive and effective machining method for hard and brittle materials. Abrasive jet machining is similar to sand blasting process but in abrasive jet machining finer abrasive powders and smaller nozzles are used. Focusing on the abrasive jet stream from the nozzle onto the work piece, smaller holes or slots can be machined on hard and brittle materials. Machining mechanism and characteristics of abrasive jet machining are major topics of many research works in the recent years .The parameters associated with abrasive jet machining are summarized .

The nozzle pressure effect has been reported in many proved that after threshold pressure, the Material Removal Rate (MRR) and the penetration rates have increased with increasing the nozzle flow pressure. Similarly, the effect of impingement angle has been reported and concluded that the maximum MRR for brittle material is obtained when normal impingement was applied. The stand-off-distance which is the distance between the work piece and the nozzle has also great effect on the material removal rate as well as the generated surface quality

Part list-

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Sr. No.	Part Name	Quantity
1.	Hose Pipe 3m long & 12mm	01
2.	Connectors ½ inch.	03
3	Coupler ½ inch.	05
4.	Cock ½ inch.	01
5.	Pneumatic Powder 120 grit	0.250 kg.
6.	Tungsten Nozzle	01
7.	Reducer & Nut	01
8.	Teflon Tape	01
9.	Clamps 15 mm.	02
10.	Base plate	1
11	M.S. Pipe chamber	01
12	M.S. Pipe flange	01
13	'T' couplor ½ inch.	2
14	Brass nipple	2
15	Glass	1
16	Dead nut	1
17	Air filter	1

II.CONSTUCTION

The process criteria are greatly influenced by various process parameters as enumerated below:

A) Pneumatics: composition, Shapes, Size and flow rate of pneumatic.

B) Carrier Gas: Pressure, Viscosity, Molecular, Weight, flow rate of carrier gas etc.

C) Nozzle: Geometrical features, material for construction, orientation with horizontal and stand-off distance.

Pneumatic jet machining is the process in which a material is removed from the work piece due to the impingement of fine grained pneumatic by high velocity gas stream. The stream of pneumatic mixed gas is directed to the work piece by suitably designed nozzles. The process differs from conventional sand blasting. In that pneumatic particles used are finer and the process parameters and cutting actions is carefully controlled. Pneumatic jet machining is applied to cut hard and brittle material such as mica, germanium, glass, ceramics etc. The process is free from vibrations and chatter problems. As no current passes from the tool and the work piece. There is no restriction to material to be machined. Thus it cuts conductive as well as non-conductive materials. The process however is no conductive to machine soft due to pneumatic particles getting embedded in the work material.

III. PRINCIPLE OF OPERATION OF PJM

The operating principle of the process is very simple. High pressure air from the compressor passes through filters and control valves into a mixing chamber. The pneumatic particles and carrier gas are thoroughly mixed in the mixing chamber and a stream of pneumatic mixed gas passes through a nozzle on the work piece. It

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

causes indentation on the work piece. The indentation ultimately results in rupture of particles from the work surface.

The nozzle geometry and its inclination, size of grit, the pneumatic used for cutting and the carrier gas pressure and the velocity are used as a criteria for evaluating PJM process.

A high velocity jet containing pneumatic particles is directed on to the work surface through the nozzle. Due to this the nozzle has to sustain maximum wear due to abrasion. Secondly, the accuracy of working and the metal removal rate depends upon the nozzle wear. The material used for nozzle should are therefore have high wear resistance. In practice the nozzle are made of tungsten carbide or sapphire having regular round or square hole. Nozzle made from tungsten carbide last for 12 to 30 hrs. When used with 27 micron pneumatic in the present study the tungsten carbide nozzle 1mm and 2 mm diameters are used.

Material and application of various unconventional methods are summarized in Table 1.

Process	Aluminum	Steel	Super- Alloy	Ceramics	Plastics	Glass
USM	P	F	P	G	F	G
PJM	F	F	G	G	F	G
ECM	F	G	G	N	N	N
CHM	G	G	F	P	P	F
EDM	F	G	G	N	N	N
EBM	F	F	F	G	F	F
LBM	F	F	F	G	F	F
PAM	G	G	G	N	P	N

TABLE 1

G= Good F = Fair

P= Poor, N= Not Applicable

PJM Shows fairly constant performance for all material process capabilities of different unconventional machines are discussed in Table 2.

Process	M.R.R. MM3/ Min	Tolerance (Micron)	Surface finish Micron CLA	Depth of surface damage (micron)	Power (Watt)
USM	300	7.5	0.2-0.5	25	2400
PJM	0.8	50	0.5-1.2	5	250
ECM	15000	50	0.5-2.5	5	100000
CHM	15	50	0.5-2.5	5	--
EDM	800	15	0.2-1.2	125	2700
EBM	1.6	25	0.2-2.5	250	150(Average) 200 (Peak)
LBM	0.1	25	0.5-1.2	125	2(Average) 200(peak)
PAM	75000	125	Rough	500	50000
Conven-tional Machining	50000	50	0.5-5	25	3000

TABLE 1

IV. PJM AS UNCONVENTIONAL MACHINE

The word unconventional is used in the sense that the metals are such that they cannot be machined by conventional methods, and require some special techniques.

PJM is included in these methods carried by high pressure as at high velocity, which is made to impinge on the work interface.

This eliminates tool to metal contact, which are the main criteria of unconventional machining method used in PJM. Following are the parameters, which affect the material removal are of the work piece.

1. Stand- off distance.
2. Pneumatic particle size and type.
3. Pneumatic jet velocity.
4. Carrier gas pressure.
5. Mass flows rate of pneumatic.
6. Nozzle diameter.

V.MERITS OF PJM

1) It is the ability to cut intricate holes in material of any hardness and brittleness.
2) It is possible to machine fragile, brittle and heat sensitive materials without damage.
3) Mechanical contact between the tool and work piece is avoided. This absence of tool work contact and metal removal at microscopic scale leads to very little or no heat generation, resulting, insignificant surface damage.
4) This sections if hard and brittle material like germanium, silicon, glass and ceramics can be machined without mechanical, thermal distortion.
5) The process can be utilized conventionally in drilling, cutting, deburring, etching, polishing and cleaning operations.
6) High surface finish can be achieved.
7) Depth of surface damage is low.
8) The process is characterized by low capital investment and low power consumption.
9) The initial cost of PJM is low.

VI. DEMERITS OF PJM

1. Limited capability owing to low material rate.
2. Embedding of the pneumatic in the work piece surface may occur while machining softer material.

3Tapering effect may be found because of the unavoidable flaring of the pneumatic jet.

4. Nozzle wear is high.
5. There must be suitable dust collection system as the process tends to pollute the environment.

VII. RESULTS AND DISCUSSION

The results indicate that time decreased with increasing the cut-off distance up to 5 mm. This is due to the abrasive stream has covered a wide area which decrease its effect on the spot. Moreover, the dimension of the required hole becomes not accurate from these results, it can be concluded that the optimum cut-off distance is 5 mm under these conditions. The effect of nozzle diameter on the material removal rate was studied at a pressure of 0.5 MPa and an abrasive sized of 0.05 mm. The increase of the nozzle diameter increases the material removal rate due to the increase of the flow rate of the abrasive particles. Moreover, the increase of the abrasive size increases the material removal rate. The results indicate that the mass of the abrasive particles is an important factor in this machining.

VIII.CONCLUSION

Experimental and theoretical analyses are introduced. The experimental and theoretical results obtained for material removal rates are close to each other within an error of not more than 20 percent which can be accepted for a mathematical model based on an erosion model. More experimental work and also more refinement for the theoretical model are needed to reduce the difference between the results as well as to introduce the neglected controlling parameters of the cutting process such as the cutoff distance.

REFERENCES

[1] Evans AG, Gulden ME, Rosenblatt ME., "Impact damage in brittle materials in the elastic–plastic response regime", Proc R Soc London, Ser A 1978; 361:343–65

[2] Ruff AW, Wiederhorn SM., "Erosion by solid particle impact"; Treat Mater Sci. Tech, 1979.

[3] Marshall DB, Lawn BR, Evans AG., "Elastic/plastic indentation damage in ceramics: the lateral crack system", J Am Ceramic Soc, 1982;65(11).

[4] Wiederhorn SM, Hockey BJ., "Effect of material parameters on the erosion resistance of brittle materials", J Mater Sci 1983; 18:766–80.

[5] Neelesh K. Jain, V.K. Jain, K. Deb, "Optimization of process parameters of mechanical type advanced machining processes using genetic algorithms", International Journal of Machine Tools & Manufacture (2006).

[6] Slikkerveer, P.J., Bouten, P.C.P., de Haas, F.C.M., "High quality mechanical etching of brittle materials by powder blasting", Sensors and Actuators, A: Physical 85 (1-3) (2000) 296–303.

[7] Wensink, H., Elwenspoek, M.C. , "Reduction of sidewall inclination andblast lag of powder blasted channels", Sensors and Actuators A: Physical 102 (1-2) (2002) 157–164.

[8] Park, D.S. , Cho, M.-W., Lee, H., Cho, W.-S. , "Micro-grooving of glass using micro-abrasive jet machining", Journal of Materials Processing Technology 146 (2) (2004) 234–240.