Influence of Natural Abrasives on Glass Cutting Process in Abrasive Jet Machining

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Abstract- *In conventional machining processes, machine tools such as lathes, milling machines, drill presses are used to cut or removal and shape a work piece through direct contact. Sometimes it is required to produce complex part geometries that cannot be produced by following conventional machining techniques. Non- Traditional method is a process there is no physical contact between the tool and work piece form a group of processes which removes excess material by various techniques involving. Abrasive jet process requires low capital cost and operational cost because the investment on equipment is very low in comparison with other non-traditional machining processes giving tighter tolerances. In this project Natural abrasive particles (sand particles) and Natural fluid (compressed air) can be used instead of conventional abrasive particles and fluids. We are checking how the process parameters are influences on the material removal rate (MRR) and surface finishing.*

I. INTRODUCTION

1.1 Abrasive jet machining

Abrasives are very expensive but abrasive jet process requires low capital cost and operational cost because the investment on equipment is very low in comparison with other non-traditional machining processes giving tighter tolerances. There exists an increasing demand to develop micro machining technologies for these difficult-to-machine materials due to their properties of extreme hardness, brittleness, corrosion resistance and low melting temperatures. Abrasive jet machining (AJM) is a non-traditional machine process which operates without producing shocks and heat. In this machining process, the high velocity stream of abrasives is generated by converting the pressure energy of carrier gas or air to its Kinetic energy and hence the high - velocity jet results. A nozzle directs abrasives in a controlled manner onto the work material. AJM is applied for many applications like cutting, cleaning, polishing, deburring, etching, drilling and finishing the operation. The process is used chiefly to cut intricate shapes in hard and brittle materials which are sensitive to heat and have a tendency to chip easily. The process can be easily controlled by varying the parameters such as Velocity, Flow rate, Pressure, Standoff distance, Grit size, and nozzle angle. Response variables like surface finish, Material Removal Rate (MRR) width is producing a cylindrical hole as shown in fig 1.1

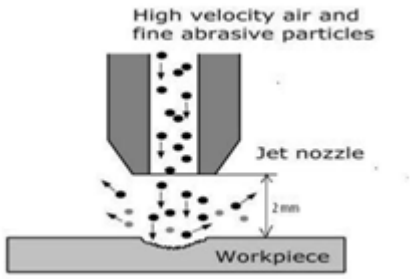


Fig1.1: Principle of AJM Process

1.2 Abrasive particles

An abrasive is a substance used to cutting, polishing operations for the materials. It should be pure and have uniform physical properties of hardness, toughness and resistances to fracture. Abrasives may be classified in two groups:

1. Natural abrasives
2. Artificial abrasives

1.2.1 Natural abrasives

The natural abrasives are produced by uncontrolled forces of nature. The following are the generally found and used natural abrasives.

A. Sand B. Emery
C. Corundum D. Diamonds

1.2.2. Artificial or Manufactured abrasives:

The quality and composition of these particles can be easily controlled and their efficiency is far better than that of natural abrasives. Most common used artificial abrasives are:

a. Silicon carbides

b. Aluminium oxides

1.3 Process parameters

In Abrasive jet machine the process parameters play major role in material removal rate. There are

1. Nozzle tip distance (NTD)
2. Abrasive flow rate
3. Fluid pressure
4. Abrasive type and size

1.4 Mechanism

When an abrasive particle having sharp edges hits a brittle and fragile material with a high speed, it makes dent into the material and lodges a small Particle from it by a tiny brittle fracture. This lodged out or wear out particle is carried away by the air or gas medium as shown in above fig 1.4

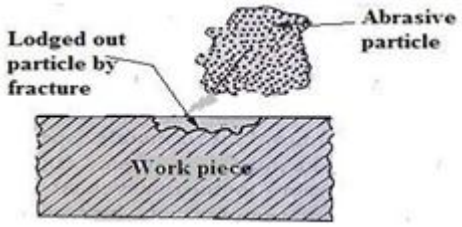


Fig 1.4: Mechanism of material removal

II. LITERATURE SURVEY

In this section the experimental analysis of Abrasive jet machining is discussed. The experimentations conducted by various researchers by influencing the abrasive jet machining (AJM) process parameters on material removal rate, Surface integrity, discussed. The parameters like SOD, Carrier gas, Air Pressure, Type of Abrasive, Size, Mixing Ratio etc. are focused.

Mr Bhaskar Chandra, et.al **[1]** was published a paper on study of effect of Process Parameters of Abrasive jet machining has been carried out a walk on the various experiments were conducted to assess the influence of abrasive jet machining (AJM) process parameters on material removal rate and diameter of holes of glass plates using aluminium oxide type of abrasive particles.

Mr Goutham Syrian, et.al **[2]** has published a paper on study of effect of process parameters on the performance of abrasive jet machining has been carried out a walk on drilling work is done on glass work piece and silicon carbide (Sic) as abrasive powder.

Mr KejuChou et.al **[3]** was published a paper on Micro abrasive jet machining of silicon carbide (Sic) fibre reinforced ceramic matrix composite has been carried on Abrasive jet machining (AJM) of silicon carbide fibre reinforced silicon carbide ceramic composite (Sic/Sic CMC) was carried out with various size of silicon carbide fine abrasives.

Mr Ivan Sumit Rout, et.al **[4]** was published a paper on Effect of Pressure on Material Removal Rate on Glass Using Abrasive Jet Machining the working of abrasive jet machining on brittle material that is glass by the application of high speed stream of abrasive particles carried by a gas medium through the nozzle.

Mr Sargam Manikyam Reddy, et.al **[5]** was published a paper on Experiment on the effects of process parameters on material removal rate in AJM during machining of Rayon based CFRP composite has been a carried out a walk on Type of abrasive particles used is silicon carbide (Sic).

III. FABRICATION OF ABRASIVE JET MACHINE

Now in this project fabricating the abrasive jet machine implementing a new Natural abrasives such as sand and Natural fluid such as compressed air .which are Nontoxic gases to in- hale for human beings while machining and These abrasives and fluids used in 'Abrasive jet machining process' which are Easily available in the nature and not Economical and Nozzles must be highly resistant to abrasion and are typically made of tungsten carbide or synthetic sapphire .we are going to increase the life of nozzle with help of Natural abrasives and fluids. We are also going to study how the process parameters influence on the material removal rate (MRR) and surface finishing such as.

1. Fluid pressure,
2. Stand-off distance,
3. Abrasive flow rate.

3.1 ABRASIVE JET MACHINE SETUP

List of Components:

1. Air storage tank
2. Mixing chamber
3. Motor
4. Pressure regulator
5. Mixture flow control valve
6. Crank mechanism

7. Working chamber
8. Non-return valve for air Bearing
9. Mixing chamber frame
10. Hoses

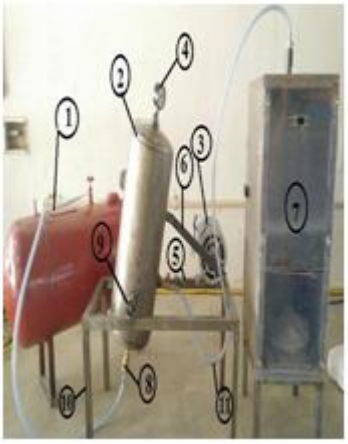


Fig 3.1: Abrasive jet machine

3.2 SPECIFICATIONS OF PARTS IN THIS SETUP

3.2.1 Air storage tank

Length: 1000 mm
Diameter: 300mm
Capacity: 110 psi

3.2.2 Mixing Chamber

Position: Vertically located
Diameter: 135 mm
Height : 300mm
Material: GI sheet metal

3.2.3 Motor

Type : Induction motor,
Capacitor start type
Power: 0. 25H.P
Speed: 1440 rpm
Efficiency: 59%

3.2.4 Connecting rod

Stroke length : 100 mm

3.2.5 Working chamber

Material: Ms Steel
Length: 325 mm
Height: 300 mm
Breadth: 775 mm

3.2.6 Bearings

Material: Bearing steel
Type : Single row deep groove ball bearing
Inner diameter: 15 mm
Outer diameter: 35 mm

3.2.7 Mixing chamber frame

Material: MS steel
Length : 675 mm
Breadth: 325 mm
Height : 300 mm

3.2.8 Hoses

Length: 1650 mm
Material: Nylon

3.2.9 Nozzles

Nozzle inlet diameter: 8.0mm
Nozzle outlet diameter: 3.0 mm
Angle of taper : 2
Length of nozzle : 30 mm

3.2.10 Work Table

Length : 175 mm
Breadth : 85 mm
Area : 14875 mm

3.2.11 Abrasives particles

Type: Natural Abrasives (Sand)
Grain size: 50 µmm

3.3 CHARACTERISTICS OF ABRASIVE JET MACHINE:

Abrasive particles:	Natural abrasives (sand)
Size of abrasives :	50µm
Flow rate :	2-20 g/min
Medium : Air	
Velocity :	150-300 m/sec
Pressure :	3-8 kg/cm2
Nozzle :	Brass
Life of nozzle :	15-40 hrs
Nozzle tip distance	: 2- 8 mm
Tolerance :	± 0.03 mm
Surface roughness:	1.0 to 1.5µm

Work material : Hard and brittle materials, glass, ceramics, sand mica.

3.4 WORKING PROCEDURE

Fig 3.4: Abrasive jet machine

Here above figure shows the working of abrasive jet machine in that we have air storage tank is there it consists of compressed air; the air can be fill by valve pin with help of compressor. The air will feed into the mixing chamber with help of non-return valve, in mixing chamber contains an abrasive particle the air and these abrasive particles are properly mixed with help of vibrator. The single-phase induction motor is used as vibrator with help of connecting rod mechanism. The mixed slurry is passed through the flow control valve with high speed stream of abrasive particles carried by a air medium through the nozzle In to working chamber, this high speed stream of abrasive particles are impinged on the glass work piece through the nozzle so that the material to be removed and produce hole. In this machine the particular drilling of holes of minimum diameter and maximum depth is also possible with greater accuracy and surface finish. **.**

IV. EXPERIMENTATION AND RESULTS

4.1 MATERIAL REMOVAL RATE (MRR)

In this project material removal rate is calculated by using the weight loss method. In weight loss method consists of the work piece whatever it be taken initially weight with help of weighing machine, and note the initial work piece weight reading. And perform the operation on the work piece for one minute with help of stopwatch in abrasive jet machine and finally take the readings of material removed work piece on the weighing machine. The difference between the initial and final readings within the time of one minute we concluded as material removal rate for one minute.

$$MRR = \frac{\text{Initial weight} - \text{Final weight}}{\text{Time}}$$

By using weight loss method, we can measure the glass work piece for 2mm thickness.

Component: 1

Here the initial weight of the work piece is 49.54 gm and this work piece is undergone one minute for machining process after completion of machining process and finally the weight of the work piece is 44.74 grams

$$MRR = \frac{49.54 - 44.74}{1}$$

MRR = 4.8 gm/min

From the given calculation, the Material Removal Rate for the given component is calculated and is 4.8 gm/min.

Pressure increases the material removal rate is gradually increases. This is due to fact that the pressure increases the particles are flow through with the high pressure that causes the material should be removed very fast. So, in increases the material removal rate.

Fig 4.1: Before and after drilling work piece

Component: 2

In this machine it is also possible to make a drilled hole on 4mm thickness glass plate as shown in below fig 4.2

Fig 4.2: Before and after drilling work piece

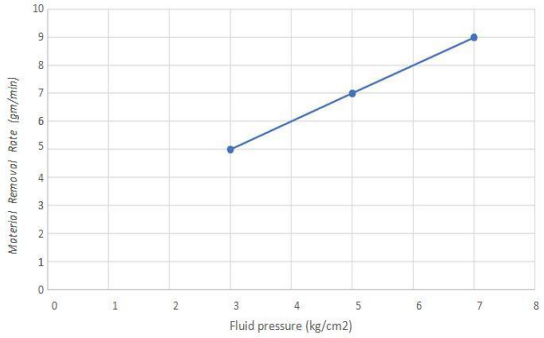
Here the initial weight of the work piece is 102.54 gm and this work piece is undergo one minute for machining process after completion of machining process and finally the weight of the work piece is 99.34 gm.

$$MRR = \frac{102.54 - 99.34}{1}$$

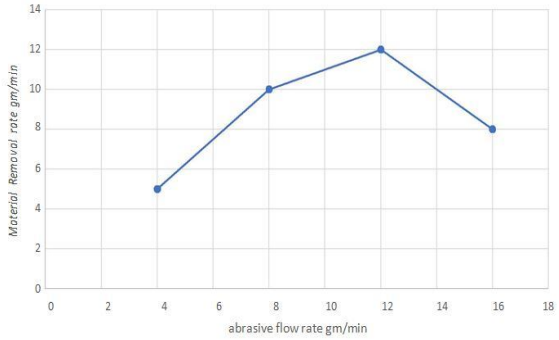
MRR = 3.2 gm/min

From the given calculation, the Material Removal Rate for the given component is calculated and is 3.2 gm/min.

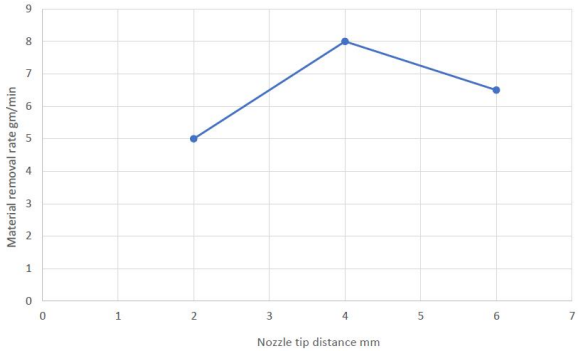
4.2.1 Graph representation between Material removal rate and Fluid pressure:



4.2.2 Graph representation between Material removal rate And Abrasive flow rate:



4.2.3 Graph representation between Material removal rate and Nozzle tip distance



V. CONCLUSION

- In Abrasive jet machining, it is recommended that Natural abrasive particles (sand particles) and Natural fluid (compressed air) can be used instead of conventional abrasive particles and fluids.
- The process parameters are such as Fluid pressure, Nozzle tip distance, and Abrasive flow rate may affect the material removal rate and surface finish.

It is observed that the natural abrasive particles with desired pressure can produce holes on brittle materials like glass, Ceramics, Mica.

VI. FUTURE SCOPE

In Abrasive jet machining the process parameters are influences on the material removal rate (MRR) and surface finishing. Such as Abrasive mass flow rate, Nozzle tip distance, Fluid Pressure, Velocity of abrasive particles, Mixing ratio, Abrasive grain size.

In Future the above-mentioned process parameters are optimized by using the optimizing techniques such as Analysis of variance (ANOVA), Response Surface Methodology (RSM) and Taguchi technique.

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