International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

MODELLING AND FABRICATION OF ABRASIVE JET MACHINE

R. Giridhar[1], K. Jayaram [2], A. Durgabhaskar[3], G. Lakshmiperumallarao[4], K. Ajaybabu[5], JP Samvijaymohan[6]

[1] Assistant professor Department of Mechanical Engineering DMSSVH College of Engineering Machilipatnam Andhra Pradesh India.
[2-6]B. Tech student Department of Mechanical Engineering DMSSVH College of Engineering Machilipatnam Andhra Pradesh India

---

Abstract –

Abrasive jet machine is a un conventional machining process where the high-pressure stream of air along with the abrasive particles are used remove the material from the brittle materials through nozzle.

The AJM is chiefly used to cut intrinsic shape on the brittle materials. The mixing chamber, nozzle is fabricated in the local market. The abrasive powder, FRL unit, hosepipes, piping, pressure regulator, and pressure gauge are bought from the market. In this project we want to fabricate AJM to study different parameters effecting the machining.

After completion of fabrication work, we had taken one of the applications of AJM i.e. drilling operation on brittle materials. We have taken glass as a work piece and Silicon Carbide (SiC) as an abrasive material. The effect of overcut and material removal rate from work piece is calculated. Before completing fabricated model, we have designed model in CREO software.

Key words: Abrasive jet, FRL unit, mixing chamber, Nozzle, MRR, Overcut.

1.INTRODUCTION

The Abrasive jet machining is a non-conventional machining process in which material is removed from the work piece due to erosion caused by impingement of high stream abrasive particles carried by a gas medium. The Abrasive jet machining is differing from conventional sand blasting by using fine abrasives and operation is done in controlled conditions.

Abrasives are small and hard particles which are having sharp edges and are in irregular shape.

The analysis of abrasive jet machine was started few decades ago and till date the study of abrasive jet machining is going on.

Dehnadfaret.al [1] has finding out the micro machined surface by applying a jet of particle passed through narrow mask opening in abrasive jet micromachining (AJM). The structure of micro machined feature depends on mass flux and particle velocity. In this experiment shadow graphy speed laser technique was used to study the size distributions and particle velocity.

Lin et.al [2] designed a hybrid model based upon combined mechanism of abrasive jet machining (AJM) and electrical discharge machining (EDM). To removing the recast layer of SKD 61 steel during the EDM process in dehumidified gas medium the AJM process was incorporated. The hybrid process not only increases the material removal rate but also generated a fine surface finish.

Park et.al [3] described that the performance of MAJM in the micro-grooving of glass. They take the diameter of the hole-type and the width of the line-type groove are 80 μm. according to the experimental result they concluded that the size of machined groove increased about 2–4 μm. they suggest that using of masking process and the compensation for film wear, MAJM process was effectively used in the machining of electronic device, LCD and semiconductor.

oms Tyagi [4] has presented a theoretical study carried out with the help of mathematical model and computational technique of abrasive jet machining which is based on the principal of velocity shear instability, generated by thermionic process. Based upon the plasma factor erosion from metallic surface can be controlled by changing the input parameter such as electrified, magnetic field and shear scale length.

Li et.al [5] determined the particle velocities at the nozzle exit based on the nozzle length particle mean diameter, air density, particle density and air flow velocity. Also modeled a numerical solution for determine the particle velocities by dividing the nozzle and the jet flow in air into small segments along the jet axial direction and it is verified with the calculated particle velocities from a particle image velocimetry (PIV) measurement of the velocity distribution in micro-abrasive air jets. Jet

Ghobeity et.al [6] presented an analytical model on AJMM in which the target is oscillated transversely to the overall scan direction, by which they predicted the shape, sidewall slope, and depth of machined planar areas and transitional slopes in glass

Jianxin [7] studied the erosion wear behavior of boron carbide nozzles, using the silica, silicon carbide and alumina powder as abrasive, on abrasive jet machining. Conclusion was derived that the hardness of abrasive particle was played an important role on wear behavior boron carbide nozzle. Boron carbide nozzle was produced by hot pressing.

COMPONENTS OF ABRASIVE JET MACHINE

1. Compressor 2. Air filter (FRL unit)

3. Mixing chamber 4. Nozzle 5 Pressure gauge 6. Pipeline and pressure regulator

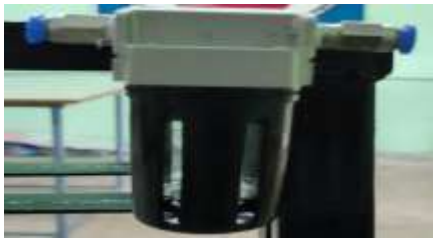
Now let's see them individually

COMPRESSOR

The air from the atmosphere is sucked and it is compressed to pressure up to 15 to 20 bar depending upon the type of compressor the compressed air is now sent to the mixing chamber through the air filter.

AIR FILTER

The air which is coming from the compressor may contain minute dust particles which are collected in air filter. The purified air is sent to the mixing chamber. Here we used automatic air filter in which excess of air is released



MIXING CHAMBER

The fine abrasive particles are mixed with the high stream air which is coming from the air compressor. These mixture of abrasive particles and high stream of air is directed towards work piece through nozzle

. The mixture of abrasives and the air is known **"ABRASIVE JET"**

NOZZLE

The abrasive jet coming from mixing chamber is passes through nozzle and the material is removed from work piece.

The distance between nozzle and work piece is called as standoff distance.

PRESSURE GUAGE

It is used to indicate the pressure of abrasive jet entering into the mixing chamber.

PRESSURE REGULATOR AND PIPINGS

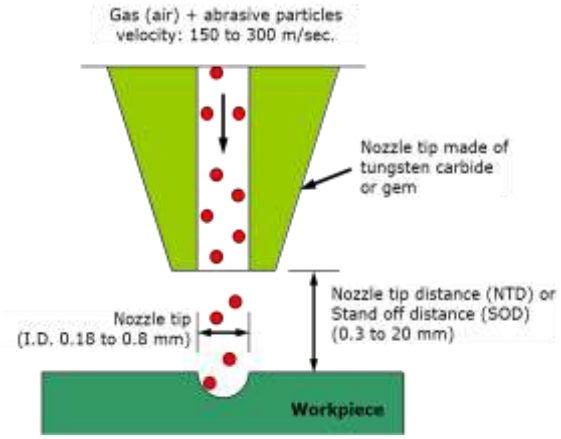
Pressure regulator is used to control the flow of air at required pressure. And piping is used to flow the air from compressor to the mixing chamber

WORKING OF AJM

The device like a tank fed into a mixing chamber. A regulator is incorporated in the line to control the flow of Abrasive particles and the compressed air is supplied to the mixing chamber through the pipeline. The pipeline carries the pressure gauge and regulator to control the gas flow and its pressure. The mixing chamber which consists of abrasive particles is vibrated the particle in gas stream travels further through hose and finally pass through a nozzle at high speed. This high-speed mixture of gas and abrasive particles is known as an abrasive jet. This abrasive jet is used to create the erosion between the surface and

the nozzle and the material is removed from the work piece

S.no	Parameters	General values
1	Abrasive material	Silicon Carbide (SiC)
2	Abrasive size	15 microns
3	Mass flow rate	2-20 gm/min
4	Air Velocity	500-700 m/sec
5	Pressure	4-8 bar
6	Standoff distance	0.3-3.5 mm
7	Nozzle diameter	1.5 ,2.0 mm
8	Medium	Air



FORMULAE

MRR is calculated by formulae

$$MRR=\frac{K*n*P^{(1.25)}*D^2*p^{(0.5)}}{T^{(0.75)}}$$

K= constant ; P=pressure

n=0.7 ; T=gas stress flow=5000mpa

p=abrasive density=2.3gm/cm^3;

D= diameter of nozzle.

Over cut is calculated by formulae

$$OC = \frac{Dw-Dt}{2}$$

where Dw =diameter of hole on work piece

Dt =diameter of nozzle

PROCESS PARAMETERS

LIMITATIONS:

Abrasive jet machining has following limitation

1. Nozzle wear is high.
2. In machining soft metals, abrasive get embedded into the metals as a result an additional cleaning operation is required
3. Process tends to pollute the environment, so, dust collecting system is required.

EXPERIMENTAL SET UP

MODELLING OF AJM

FUTURE SCOPE

1. A Precision AJM will be used in gear mechanisms, crankshaft, springs etc.
2. More number of experiments can be done by using nozzle material as tungsten carbide, boron carbide.

RESULTS

Pressure	Stand off distance (mm)	Nozzle diameter(mm)	MRR (mm^3/sec)	Overcut (mm)
4	3	1.5	0.0127	0.2
4	3	2.0	0.0227	0.3
6	3	1.5	0.0212	0.175
6	3	2.0	0.0377	0.3

CONCLUSIONS

1. In this project, a complete model of abrasive jet machine is fabricated in the institute. A complete CAD model was designed in Creo software.
2. Most of the components are made locally and sophisticated parts which affect the accuracy greatly and are procured from outside.
3. In this we had taken one of application of ajm i.e. Drilling a hole on a brittle material (glass) of thickness of 5,6 mm.
4. In this project Both the vice and also nozzle can slide, so the hole can be drilled at our required position
5. The results obtained i.e. both MRR and over cut are recorded carefully.

REFFERENCES

1. D. Dehnadfar, J. Friedman, M. Papini (2012), "Laser shadowgraphy measurements of abrasive particle spatial, size and velocity distributions through micro-masks used in abrasive jet micro-machining," Journal of Materials Processing Technology, Vol. 212, pp. 137- 149

2. Y. Lin, Y. Chen, A. Wang, W. Sei (2012), "Machining performance on hybrid process of abrasive jet machining and electrical discharge machining," Transactions of Nonferrous Metals Society of China (English Edition), Vol. 22, pp. 775-780.

3. R.K. Tyagi, (2012) "Abrasive jet machining by means of velocity shear instability in plasma." journal of manufacturing process," Vol. 14, pp. 323-327.

4. H.Z. Li, J. Wang, J.M. Fan (2009), "Analysis and modelling of particle velocities in micro-abrasive airjet,"International Journal of Machine Tools & Manufacture, Vol. 49, pp. 850-858.

5. R.K. Tyagi, (2012) "Abrasive jet machining by means of velocity shear instability in plasma." journal of manufacturing process," Vol. 14, pp. 323-327.

6. A. Ghobeitya, M. Papinib, J.K. Spelta (2009), "Abrasive jet micro-machining of planar areas and transitional slopes in glass using target oscillation,"Journal of Materials Processing Technology, Vol.p 209, pp. 5123-5132.

7. Deng Jianxin (2005), "Erosion wear of boron carbide ceramic nozzles by abrasive airjets,"Materials Science and Engineering A, Vol. 408, pp. 227-233.

BIOGRAPHIES

R.GIRIDHAR
Assistance Professor, Department of mechanical engineering

K. JAYARAM
B.Tech Student

A. Durga Bhaskar
B. Tech Student

G. Lakshmi Perumalla Rao
B. Tech Student

K. Ajay Babu
B. Tech Student

JP Sam Vijay Mohan
B. Tech Student