Fabrication of The Abrasive Jet Machine For Acrylic Cutting

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Abstract- *Abrasive jet machining is a non-conventional machining process which is widely used in machining of metals for different hardness. In this machining process a focus stream of abrasive particles are forced to impinge on work piece with the high velocity jet. These high velocity abrasive jet remove metal by brittle fracture or erosion from work piece. This machining process works on the basic principle of abrasive erosion. If a high velocity abrasive jet strike on a hard or brittle work piece, it removes some metal at the striking surface. This metal removal process takes place due to brittle fracture of metal and also due to micro cutting by abrasive particles. This is principle process of abrasive jet machining. We are fabricating this model of AJM so that students from college of Engineering, Phaltan can be able to know the actual working of advanced manufacturing processes. We have fabricated the AJM in which it can easily cut acrylic material.*

Keywords- Abrasive material, AJM, acrylic, etc.

I. INTRODUCTION

Abrasives particles 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 nonconventional machining processes giving tighter tolerances. As the carrier gas serves as a coolant, the cutting action is cool and hence better surface finish can be obtained. Now days it is widely used in manufacturing of electronic devices, LCD's, tribo-elements, MEMS, and semiconductors. There exists an increasing demand to develop micromachining 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 nontraditional 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 nozzle is the most critical part in the abrasive air-jet equipment. 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), kerfs width is producing a cylindrical hole.

In abrasive jet machining, a focused stream of abrasive particles, carried by high pressure air or gas is made to impinge on the work surface through a nozzle and the work material is made to impinge on the work surface through a nozzle and work material is removed by erosion by high velocity abrasive particles. Material is removed by fine abrasive particles, usually about 0.001 in (0.025 mm) in diameter, driven by a high velocity fluid stream; common gases are air or inert gases. Pressures for the gas range from 25 to 130 bar and speeds can be as high as 338 m/s.

II. OBJECTIVES

1. To fabricate a small abrasive jet machine so that students from College of Engineering Phaltan (Diploma) can be able to know the actual working of advanced manufacturing process.
2. Abrasive Jet Machine can cut intricate hole and other shapes in acrylic plate.
3. Ability to cut fragile and heat sensitive material like acrylic without damage.
4. To make the machine portable.

III. LITERATURE SURVEY

Saiprasad Sutara and K. R. Jagtapb [1] presented the an explore review of the current situation and research of abrasive jet machine also the difficulties and resolved solutions by various researchers on them it basically deals with 1.characteristics study of flexible magnetic abrasive in abrasive jet machining2.Machining of Micro-holes on Soda lime Glass using Developed Micro-Abrasive Jet Machine

.improvement of the geometrical accuracy of micro hole machined through µ-AJM.

S. Rajendra Prasad and et. al., [2] presented the era of modern machining, these requirements can be achieved with the help of advanced machining process like Abrasive Jet Machining (AJM).This paper presents an extensive review of the current state of research and development on abrasive jet machining process.

N. Sathish Kumar and et. al., Abrasive jet machining is a non-traditional machining process which is mostly used in machining of hardened metals. In this machining process a focus stream of abrasive particles are forces to impinge on work piece at high velocity. These high velocity abrasive particles remove metal by brittle fracture or erosion from work piece. This machining process works on the basic principle of abrasive erosion. If a high velocity abrasive particles strike on a hard or brittle work piece, it removes some metal at the striking surface. This metal removal process takes place due to brittle fracture of metal and also due to micro cutting by abrasive particle. This is principle process of abrasive jet machining. This paper presents the application of an elasto-plastic model based explicit finite element analysis(FEA) to model the erosion behavior in abrasive jet machining(AJM).

IV. WORKING

1. The operating principle of process is very simple. High pressure air from the compressor passes through filters and control valves into mixing chamber.
2. The abrasive particles of aluminium oxides (10-50µm) and carrier gas which is air are thoroughly mixed in the mixing chamber and a stream of abrasive mixed gas passes through a nozzle on the work piece.
3. It causes indentation on the work piece. The indentation ultimately results in Capture of particles from the work surface.
4. This abrasive jet has the velocity of 338m/s. With its stand-off distance 0.15 to 15mm. Also we can set this nozzle at angle 90°.
5. Nozzle has its diameter of 0.25mm so that it can easily cut and give required shape to the non-metals, glass, acrylic plates, etc.
6. Cutting done by this process have good finishing and it can be easily seen from the glass of machine in front panel.
7. Depending upon the material to be cut we can vary this parameters of pressure of carrier gas, stand-off distance and impact angle.

V. ACTUAL MODEL

Figure 1- Abrasive Jet Machine model

VI. CALCULATION FOR NOZZLE

$$p_o = p_s + \frac{1}{2}\rho v^2$$

$$1.7 \times 10^5 = 1 \times 10^5 + \frac{1}{2} 1.225 v^2$$

$$0.7 \times 10^5 = \frac{1}{2} 1.225 v^2$$

$$v = 338 \text{ m/s}$$

VII. CALCULATION FOR VOLUME FOR MIXING CHAMBER

Density of silicon carbide =1.3gm/cc

Assume 100gm abrasive particle stored in hopper

$$\text{Volume of cylinder} = \frac{\text{mass of abrasive particle}}{\text{density of abrasive particle}}$$

$$= \frac{100gm}{1.3gm/cc}$$

$$= 76.92cc$$

VIII. CONCLUSION

1) We have fabricate a small abrasive jet machine using that students from College of Engineering Phaltan (Diploma) now be able to know the actual working of advanced manufacturing process.
2) Abrasive Jet Machine cuts intricate holesand other shapes in acrylic plate.
3) AJM have cut fragile and heat sensitive material like acrylic without damaging the other part of workpiece

4) By making the design compact and robust we made the machine portable.

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