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Inspection: Abrasive Jet Machining

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Abstract: Advance machining processes where greater precision and finishing of the surface are required. One of these processes is abrasive jet processing, in which a high-pressure stream of air and abrasive particles impact an operating area via a nozzle. Abrasive jet method Abrasive jet machine (AJM) can be used for cutting, grinding, dismantling, etc. to extract material by means of a centered jet beam aimed at the work piece. AJM has become a useful technology for micro-machining with the increasing demand for machining pottery, semi-conductors, electronic devices and LCD. Less useful in precision job industries, during this phase, removal rate affects different parameters such as abrasive particle size, abrasive flow rate velocity, gas pressure and stopping distance and so on.

Keywords: Abrasive Jet Machine, Process, AJM Working, Advantage and Disadvantage, Application, Parameters.

INTRODUCTION

Abrasive jet machining (AJM) is a nontraditional processing machine that operates without physical contact between the machine and its work piece and does not create thermal loads or shocks. For numerous applications, AJM is used such as cutting, cleaning, polishing, debarring, etching, boiling and finishing. Abrasive particles are created in abrasive jet machining to impact high-speed working material. The carriage gas or air holds a stream of abrasive particles. By converting pressure energy from conveying gas and air to its kinetic energy and thus high velocity jet, the high-speed flow of abrasives is generated. Controlling the nozzles direct abrasive jet to operate, with a micro-cutting effect the material is removed by the high-velocity abrasive particles and the work material is fractured.

1. *Abrasive Jet Machining:*

Initiated by Franz in 1968 to cut laminated paper pipes, this new technology was first introduced in 1983 as a commercial system. Genet was added to the water stream in the 1980s and the abrasive throttle came into being. At the beginning of the 1990s Dr. John Olsen, water jet pioneer, started exploring the idea of abrasive jet cutting as a practical alternative for conventional machinery businesses. Its ultimate goal was to develop a system to eliminate the noise, dust and expertise required at that time by abrasive jets [1]. A wide range of research and development in AJM has been carried out over the past two decades.

2. *Process: Abrasive Jet Machining*

A. *Components:*

- *Filter:* The main purpose of using a filter is to purify the air/gas passed through it by removing an unnecessary or unwanted particle from air/gas flow.

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- *Vibrator: The* vibrator's primary function is to mix two materials correctly by means of vibration mechanisms.
- *Pressure Regulator:* The pressure of the line is controlled by a pressure controller. The main function of a pressure controller is to match the gas flow through the gas place controller on the system. A loading element and a measuring element are included in a pressure control unit.
- Gas/air Supply Cylinder/Compressor
- *Nozzle:* The abrasive particles are directed through nozzles to the working surface at high speed. Distance from the work piece influences the rates of the removal of materials and the size of the machined area.
- *Guide ways:* The x-y table is the most important part of the AJM for maintaining and machining the work piece. The main function of the guide is to ensure that the operational element of the machine tool move along the default path. The guideline provides a smooth and linear movement in the machine tool, which ensures higher precision and precision. Guide route has a load bearing and linear movement function at the same time.
- *Mixing Chamber:* A mixing chamber is a small room where the gas / air abrasive fluid is correctly combined with vibrator.
- *Foot Control Valve:* It is used by the controlling valve to maintain the necessary pressure to remove material from the work piece at the end of the box.
- *Abrasive:* An abrasive material is used for the formation or finish of a work piece by rubbing that leads to the wear of part of the work piece. When a material is finished, it often means that a smooth surface is pollinated. Different types of abrasives are used for the cutting and drilling process silicone oxide (SiO_2), silicon carbide (Sic), aluminum oxide (Al_2O_3). Fig.1 shows diagram of Abrasive jet machining

3. Working Process:

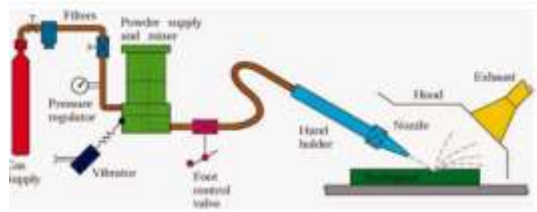

Fig.1: Diagram of Abrasive Jet Machining

- First, the supply of gas / dry air from the compressor/cylinder to a filter is provided.
- The air / gas moves to the pressure regulator after filtration, indicating air / gas flow pressure.
- This air / gas are then mixed to the mixing chamber using the vibrator attached to this with abrasive particulate powder.
- The mixer then reaches an abrasive particle & air / gas valve which uses the necessary mixer pressure at the tip of the nozzle.
- Mixer reaches the nozzle with enough pressure, bug increase the mixer's rate and strikes the work piece at a very high speed; say about 300 meters per second.
- Thus, the removal of material can take place & workmanship because of the high speed of air-abrasive mixer strikes in the work surface.

Figure 2 shows the abrasive jet machining.

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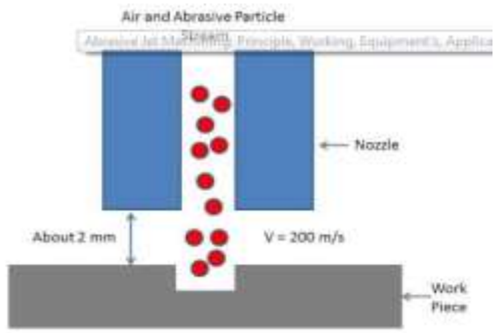

Fig.2: Abrasive Jet Machining

4. Advantage and Disadvantage:

Advantages:

- It is possible to obtain the superior surface finish.
- The cost of capital is small, and the operation and maintenance of AJM are simple.
- Ability to cut delicate material avoiding damage that is hard to heat and heat sensitive
- This makes nice cuts to the tool, so that fragile and sensitive material can be machined, as can fine parts of hard-broken materials such as germanium, mica, silicone, glass and ceramics.
- It is able to cut complex form hole of any hardness and fragility.

Disadvantages:

- If used for cutting, quick stopping speeds damage the nozzle.
- Small MRR capability limited MRR's 40 gm. / minute for glass.
- The air emissions reduction and health threats include a dust recovery system.
- The sharp borders are worn, and smaller particles can bind the bucket. Abrasive powders cannot be used again.
- Life of the nozzle (300 hours) is limited.
- It's hard to avoid stretching.

5. Applications of AJM:

- Grinding or Etching.
- AJM is in use in electronic equipment manufacturing, glass boiler, plastic disassembly, the development of nylons, Teflon pieces, plastic stencils static labels, titanium foil cutting.
- Used to drill, cut, disassemble etch and polish hard and delicate materials.
- This is used more economically for abrasion and frosting of glass.
- Cleaning of materials with metallic plates, metal oxides, etc.
- Used to cut thin fragile parts such as germanium, silicone etc.

6. Actual Parameter:

Following are certain key abrasive jet processing parameters which influence the material removal rate (MRR) directly or indirectly during the process.

a. Abrasive Mass Flow Rate:

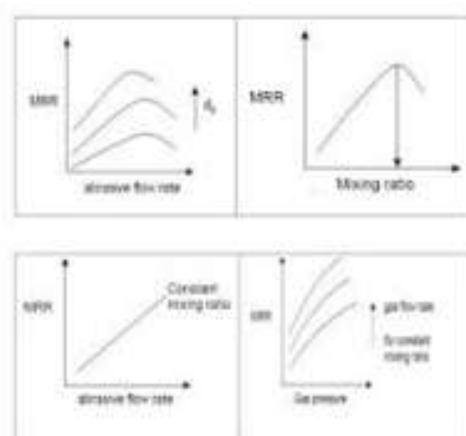

Fig.3: Effects of Abrasive Flow Particles

This is because the widespread flow rate of gas falls due to an increase in abrasive flow, as well as the mixing ratio, therefore rises, contributing to mitigation in material removal rate due to the reduced energy available for erosion.

b. Effect of gas exit speed and abrasive densities of particles:

Change in the exit gas velocity for abrasive density of particles, with the abrasive particle density changes significantly as shown in Figure 3. The velocity of carrier gas conveying the abrasive particles, once the inner gas pressure is nearly twice that at the end of the nozzle, the output velocity of the gas can also be increased above the critical level [2]. With a gradual increase in the density of abrasive particles, the exit speed will continue to decline with the same pressure condition. It is because kinetic gas energy is used to transport the abrasive particle.

c. Mixing effect for MRR Effect:

The increased abrasive material flow rate increases the fluid speed and therefore decreases the available erosion energy and consequently the MRR. This is why "mixing the ratio" should be explained [3]. By increasing the abrasive flow rate, a material removal rate can be improved provided that the mixing ratio is constantly maintained. A simultaneous increase in the gas and abrasive flow rate is the only way of changing the blending ratio. A trial and error predict an optimum mixing ratio that gives maximum MRR [4].

d. Nozzle effect on MRR Effect:

By increasing the carrier gas flow rate the abrasive flow rate can be increased [5]. Only by increasing the pressure of the inner gas as the figure shows is this possible. With the internal gas pressure increasing abrasive mass flow rate, MRR increases. Indeed, with increased gas pressure, the materiel reduction rate will increase. Kinetic energy in the abrasive particles removes the material by erosion. The abrasive must affect the working surface with a minimum speed of about 150 m / s for processing glass by SIC particle.

CONCLUSION

- When product extraction is of the greatest importance, a greater stands off range is preferable.
- Higher pressures and lower standing distances for higher precision work are used to achieve a higher precision and penetration rate for AJM.
- MRR increases with increased abrasive jet flow rate, mixing rate, internal pressure, stopping distance.

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