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Design and Fabrication of Abrasive Jet Machining

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Abstract: Abrasive jet machining is the non-traditional material removal process. It is an effective machining process for processing a variety of Hard and Brittle Material. And has various distinct advantages over the other non-traditional cutting technologies, such as, high machining versatility, minimum stresses on the work piece, high flexibility no thermal distortion, and small cutting forces. This paper presents an extensive review of the current state of research and development in the abrasive jet machining process. Further challenges and scope of future development in abrasive jet machining are also projected. This review paper will help researchers, manufacturers and policy makers widely.

Keywords: Abrasive jet machine (AJM), Material removal rate (MRR), Stand-off distance (SOD), Abrasive mass flow rate, Glass, versatility, flexibility, non-traditional

1. INTRODUCTION

Abrasive jet machining (AJM) is a processing non-traditional machine which operates materials without producing shock and heat. AJM is applied for many purposes like drilling, cutting, cleaning, and etching operation. In Abrasive jet machining abrasive particles are made to impinge on the work material at high velocity. A jet of abrasive particles is carried by carrier gas or air. 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. Nozzles direct abrasive jet in a controlled manner onto work material. The high velocity abrasive particles remove the material by micro-cutting action as well as brittle fracture of the work material. Machining, Drilling, Surface Finishing are the Major Processes that can be performed efficiently.

The process parameters are used like variables which effect metal removal. They are carrier gas, abrasive, and velocity of abrasive, work material, and nozzle tip distance (NTD). Abrasive jet cutting is used in the cutting of materials like: Titanium, Brass, Aluminum, Stone, Any Steel, Glass, Composites etc.

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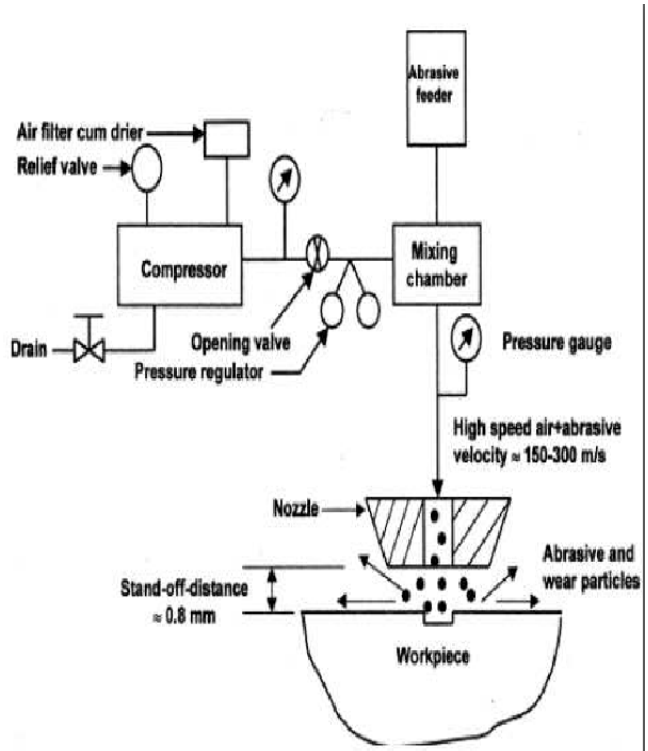

Fig 1: Schematic Diagram of AJM

2. Background

This novel technology was first initiated by Franz to cut laminated paper tubes in 1968 and was first introduced as a commercial system in 1983. In the 1980s garnet abrasive was added to the water stream and the abrasive jet was born. In the early 1990s, water jet pioneer Dr. John Olsen began to explore the concept of abrasive jet cutting as a practical alternative for traditional machine shops. His end goal was to develop a system that could eliminate the noise, dust and expertise demanded by abrasive jets at that time. In the last two decades, an extensive deal of research and development in AJM is conducted.

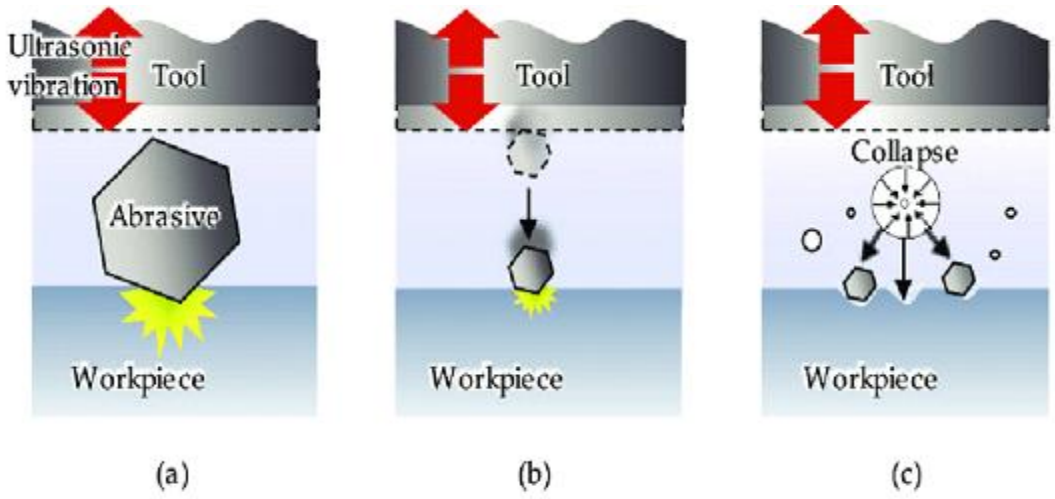

Figure 2. Material Removal by Erosion

3. Abrasive Jet Machining Parts or Construction:

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Abrasive Jet Machining Consists of following Various Parts:

a. Gas Supply
b. Filter
c. Pressure Gauge
d. Mixing Chamber
e. Nozzle and
f. Abrasive

a) Gas Supply:

A high-velocity jet of airlike nitrogen carbon dioxide etc and enclosed abrasive particles is aimed at the workpiece under controlled conditions. The gas, supplied under a pressure of 2 to 8 kilopascal.

b) Filter:

The filter is used to cleaning the fuel supply so that dirt or other impurities do not hamper the progress of the process.

c) Pressure Gauge:

The pressure gauge is used to control the pressure of the compressed used in the abrasive jet machining.as the pressure decides the depth of cutting and amount of force required for cutting.

d) Mixing chamber:

In the mixing chamber abrasive powder is being fed and with the help of a vibrator amount of abrasives can be controlled. So that the abrasives and the gases will be mixed thoroughly in the mixing chamber.

e) Nozzle:

The nozzle is used to increase the velocity of the fine abrasive jet slurry at the expense of the pressure as we know if we decrease the pressure the velocity will increase. The velocity of the jet will be around 100-300m/s.The nozzle can be adjusted accordingly so that the desired angular cutting can be achieved and the material will be removed by impact erosion.The nozzle is usually made up of tungsten carbide because it is subjected to a high degree of wear. The diameter of the nozzle is around 0.2-0.8mm.The material of the nozzle should be able to withstand corrosion. The nozzle is made of either circular or rectangular cross-section and the head can be straight or at a right angle.

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f) Abrasives:

Silicon carbide, aluminum oxide glass beads are used as abrasives in abrasive jet machining. The shape of the abrasives can be regular or irregular. The size of the abrasives is around 10 to 50 microns. The mass flow rate of the abrasives is around 2-20 grams/min.The selection of abrasives depends upon MRR, type of work material, and type of machining accuracy required.Aluminum oxide (Al2O3) size of 12, 20, 50 microns and it is good for cleaning, cutting, and deburring, Dolomite size of 200 mesh and it is used for Etching and polishing. Sodium bicarbonate size of 27 microns and used for Cleaning, deburring, and cutting of soft material.

4. CONCLUSION

According to the various research papers available till date, lot of work has done on abrasive particles and its geometry, different process parameters, volume of material removal during machining. Very less research has been done on study of effect of abrasive flow rate on performance characteristics. Hence there is scope for improvement for the study of effect of abrasive flow rate on performance characteristics like material removal rate and taper angle. Improper mixing chamber construction causes various problems such as abrasive powder stratification, powder compaction, powder humidification etc. This affects the machining results undesirably

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