ABRASIVE JET MACHINING

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ABSTRACT

A machining operation is basically termed a material removal process, where material is removed in the form of chips. In a machining operation, the output parameter is achieved by controlling various input parameters. This paper discusses the effects of various input parameters in abrasive Jet machining (AJM) on the output parameter(Metal Removal Rate [MRR).This paper presents an extensive review of the current state of research and development in the abrasive jet machining process. Further difficulties and future development in abrasive jet machining are also projected. This review paper will help researchers, students, manufactures to understand 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*

INTRODUCTION

Abrasive Jet Machine (AJM): 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 nontraditional 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, de burring, 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. Abrasive jet machining (AJM) is a processing nontraditional machine which operates materials without producing shock and heat. A 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.

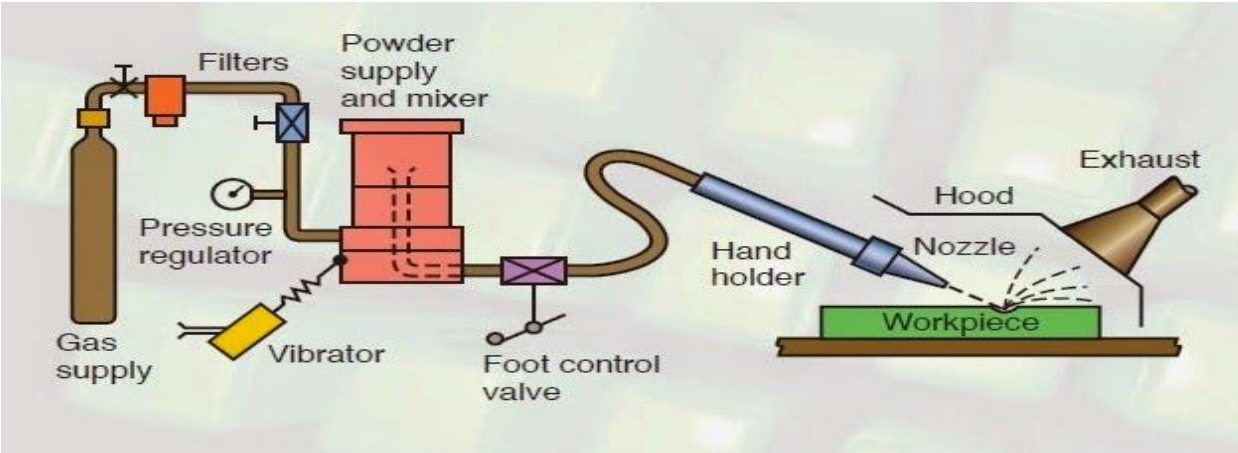

Fig.01 Schematic Diagram of AJM

Principle of AJM

Fine micro abrasive particles are accelerated in a gas stream (commonly air at a few times atmospheric pressure). The particles are directed towards the focus of machining (less than 3 mm from the tip). As the particles impact the surface, they fracture off the surface and create cavities. As the particle impacts the surface, it causes a small fracture, and the gas stream carries both the abrasive particles and the fractured (wear) particles away.

Material Removal :

- The abrasive particles from the nozzle follow parallel paths for a short distance
- Then the abrasive jet flares outward like a narrow cone.

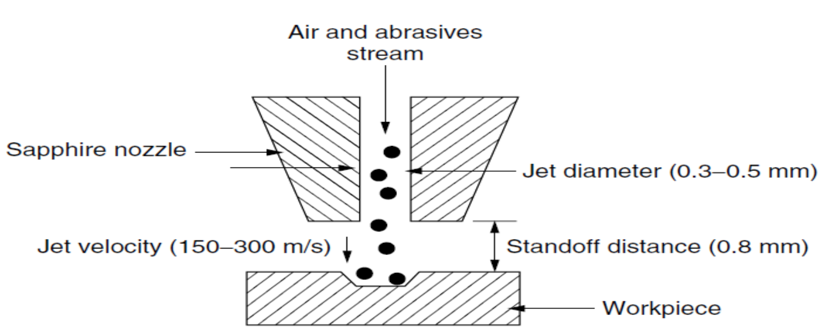

Fig.02 Schematic Diagram of AJM

- When the sharp-edged abrasive particles of Al_2O_3 or SiC hit a brittle and fragile material at high speed, tiny brittle fractures are created from which small particles dislodge.
- The dislodged particles are carried away by the air or gas.

Applications:

- Drilling holes, cutting slots, cleaning hard surfaces, debarring, polishing,

  and radioing.
- Deburring of cross holes, slots, and threads in small precision parts that require a burr-free finish, such as hydraulic valves, aircraft fuel systems, and medical appliances**.**

- Machining intricate shapes or holes in sensitive, brittle, thin, or difficult-to-machine materials.
- Insulation stripping and wire cleaning without affecting the conductor.
- Micro-deburring of hypodermic needles.
- Frosting glass and trimming of circuit boards, hybrid circuit resistors, capacitors, silicon, and gallium.
- Removal of films and delicate cleaning of irregular surfaces because the abrasive stream is able to follow contours.

Limitations:

- The removal rate is slow.
- Stray cutting can't be avoided (low accuracy of ± 0.3 mm)
- The tapering effect may occur especially when drilling in metals.
- The abrasive may get impeded in the work surface.
- Suitable dust-collecting systems should be provided.
- Soft materials can't be machined by the process.
- Silica dust may be a health hazard.

Ordinary shop air should be filtered to remove moisture and oil

Background :

This novel technology was first initiated by Franz to cut laminated paper tubes in 3968 and was first introduced as a commercial system in 3983. In the 3980s garnet abrasive was added to the water stream and the abrasive jet was born. In the early 3990s, 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.

LITERATURE REVIEW

In this section, experimental analysis of abrasive jet machine is discussed. The experiments and research are done by the various researchers regarding abrasive jet machine are focused. Parameters such as the velocity of gas,pressure, nozzle tip distance (NTD) are explained. also material removal rate (MRR), substance integrity discussed along with operation such as cutting, drilling. Jiuan-Hung Ke gives novel method along with feng-Che Tsai, Jung-Chou Hung, and biing –Hwa Yan on characteristics study of flexible magnetic abrasive in abrasive jet machining which suggests that self-made magnetic abrasive with elasticity are utilized to get machining characteristics in Abrasive jet machining

.abrasive jet machine has may other advantages as high etch rate, good machining flexibility low capital and operation cost. Nowadays the quality of abrasive jet machined surface could be improved by parameter optimization just because jetted particles was affected by air resistance after performing the experiment they made a result, Taguchi trial .According to Taguchitrial, a magnetic field is a main factor for surface roughness difference and material removal. In abrasive jet machining, they use the flexible magnetic abrasive not only to restrain the abrasive jet direction and enhance more uniform actual operational area and material removal rate but also have a permanent effect to obtain good surface roughness than normal machining process.

Kumar Abhishek and So mashekharhire math studied wide applications of the micro abrasive jet machine. i.e Machining of Micro-holes on Soda lime Glass using Developed Micro-Abrasive Jet Machine To produce micro features such as micro holes on brittle materials .

This process is also favorable for to machine heat sensitive materials. It has wide industrial applications and in engineering fields also. This paper analysis optimal machining parameter to machining hole on soda lime glass thickness.

CONCLUSION

According to the various research papers available till date, a lot of work has done on abrasive particles and its geometry, different process parameters, the volume of material removal during machining. An extensive review of the research and development in the AJM has been conducted in this paper. It was shown that AJM process is receiving more and more attention in the machining areas, particularly for the processing of difficult-to- cut materials. Its unique advantages over other conventional and unconventional methods make it a new choice in the machining industry. Very less research has-been done on the study of the effect of abrasive flow rate on performance characteristics. Hence there is scope for improvement for the study of the 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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