



A Study on Design and Fabrication of Abrasive Jet Machining

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ABSTRACT: Abrasive Jet Machining (AJM) is the process of material removal from a work piece by the application of a high-speed stream of abrasive particles carried in a gas medium from a nozzle. The material removal process is mainly by erosion. The AJM will chiefly be used to cut shapes in hard and brittle materials like glass, ceramics etc. the machine will be automated to have 3 axes travel. The different components of AJM are Horizontal motion module, Vertical motion module, Vibrator, dehumidifier, Pressure Regulator, and Dust filter etc. In this project, a model of the Abrasive Jet Machine is designed using CAD packages like AutoCAD, CATIA etc.

KEYWORDS: Nozzle, Air Compressor, Cylinder, Motor.

I. INTRODUCTION

Abrasive Jet machining is nontraditional manufacturing process that can make complex shapes on the surface of the hard and brittle material. It is a process of material removal through the action of a focused stream of fluid with abrasive particles. It is especially used for machining super alloys, ceramics, glass and refractory materials. Here, the material removals are mainly due to the impingement of the fine abrasive particles on the work surface. The metal cutting occurs due to erosion caused by the abrasive particles impacting the work surface at a high speed. As a result of repeated impact, small bits of material get loosened and separated from the workpiece surface, exposing a fresh surface to the jet. The AJM is different from conventional sand blasting as the latter is a surface cleaning process and AJM is a metal cutting process. The process is used mainly to cut complex shapes in hard and brittle materials which are heat sensitive and have a tendency to chip easily. AJM is also used for removing burrs and cleaning operations. AJM is free from vibration and chatter problems. As the carrier gas itself serves as a coolant, the cutting action is cool. [2]

II. LITERATURE REVIEW

1. It is been stated that as the particle size increases, the MRR at the central line of the jet drastically increases. As the central line velocity of jet increases, the MRR at the central line of the jet drastically increases, but there is no increase in MRR nearer to the periphery of the jet. The increase in entry side diameter and edge radius is not significant. As the peripheral velocity of the jet increases, the edge radius and entry side diameter increase. It also increases the MRR. [3]
2. Experimental study to understand the effect of process parameters like nozzle diameter, air pressure, abrasive mass flow rate on the cutting performance measures like groove depth and width. Groove depth increases by increasing the abrasive mass flow rate which leads to more particles impinging the target surface and gives more material removal. However, excessive abrasive flow rate increases inter-particle collision which reduces the average removal rate per particle. [5]

III. THE FOLLOWING ARE THE COMPONENTS OF ABRASIVE JET MACHINING [4]

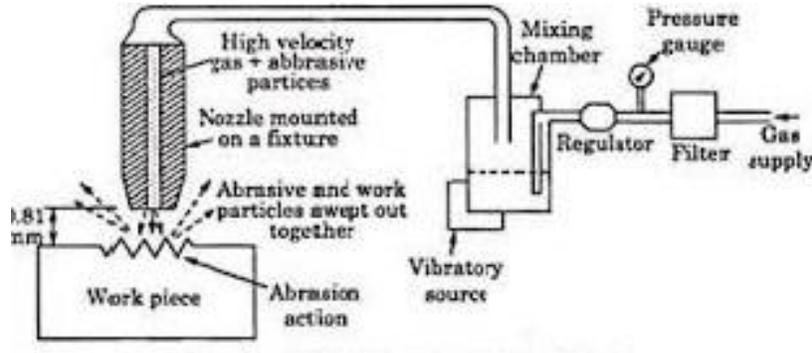


Fig 1 Abrasive Jet Machining

The components are: -

1. Air compressor.
2. Air filter.
3. Dehumidifier.
4. Pressure gauge.
5. Mixing chamber.
6. Pressure regulator.
7. Nozzle.
8. Machining chamber.
9. Vibrator.
10. Work holding device.

IV. CONSTRUCTION OF ABRASIVE JET MACHINING

4.1. MODELLING

1. Gas Cylinder.



Fig 2 Gas cylinder fitted with pressure gauge

Gas cylinder contains filtered gas which is under pressure. Pressure of the gas in cylinder can be varied by turning the pressure valve fitted into it.

2. Mixing Chamber.



Fig 3 3D image of Mixing Chamber

Mixing chamber contains the filtered gas which is been supplied from cylinder. In mixing chamber all the gases and air is mixed well in the mixing chamber with the help of the vibrator.

3. Abrasive

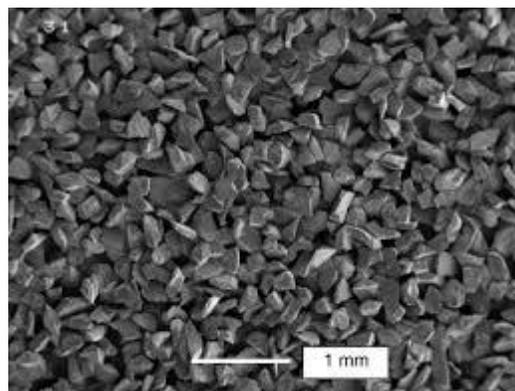


Fig 4 Abrasive Particles

Aluminum oxide and silicon dioxide are the commonly used abrasive particles. The size of the abrasive particles varies from 10-50 micro meter. Smaller size of abrasive particles is used for polishing and cleaning, while the larger ones are used for cutting and peening operation.

4. Nozzle.

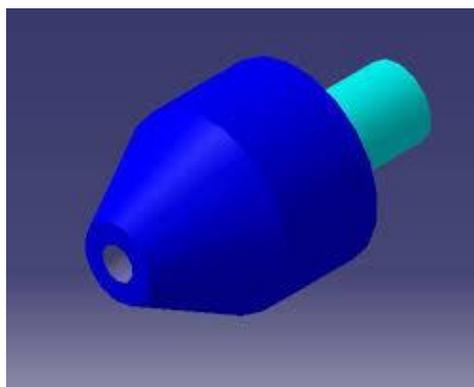


Fig 5 Nozzle

The nozzle was used for the general purpose of increasing the velocity of the mixture of compressed air and abrasives. Since the abrasive particles leave the nozzle at a very high velocity, it is subjected to abrasion wear. It is for the reason nozzle is made from a hard material like tungsten carbide. The nozzle was fabricated using EDM. The material used was D-2 steel.

4.2. FABRICATION

1. Mixing chamber.



Fig 6 Mixing Chamber

The designing of the mixing chamber was done specially for proper mixing of the compressed air and abrasives. For fabricating this a seamless mild steel pipe was used. Three holes were drilled on the structure, the first at the top, the other two were on the surface. The top hole was used to pass on the abrasives into the chamber. From the two holes on the surface, one was used to pass the compressed air from the dehumidifier and the other brought out the mixture of compressed air with abrasive to the nozzle.

2. Nozzle.



Fig 7 Nozzle

The nozzle was used for the general purpose of increasing the velocity of the mixture of compressed air and abrasives. The nozzle was prepared from a cylindrical block which underwent plain turning in the beginning. The nozzle was then tapered for the required use. Inside tapering was done using different drill bits in continuation. The nozzle was fabricated using EDM.

The material used was D-2 steel.

V.COMPOSITE ASSEMBLY

After fabricating different components of abrasive jet machining, a frame like structure was designed and fabricated which supports all the major components of abrasive jet machining. The figure shows the assembly design of abrasive jet

machining. All the above components, including dehumidifier, carrier gas supply line and pressure gauge were mounted on the frame, which gives the overall experimental setup. [1]



Fig 8 Complete Assembly

VI. ADVANTAGES OF AJM

1. It is able to cut brittle, fragile or glass and heat sensitive material without damage.
2. It is able to cut intricate shape or complex profile in hard or brittle materials.
3. As the machining action is cool, so in this process, no heat is generated.
4. No tool change required.
5. High-quality surface finish.
6. The surface of the work piece is cleaned automatically.
7. Capital cost is low.

VII. DISADVANTAGES OF AJM

1. Very low material removal rate.
2. The process produces a taper cut always.
3. In certain substances, abrasive particles might settle over the work piece.
4. Nozzle life is less.
5. It can't be used machining soft materials.
6. It can't be used to drill blind holes.

VIII. APPLICATIONS OF AJM

1. Used in cutting slots, thin sections, contouring, drilling.
2. It can be also used for etching and deburring process.
3. It is sometimes used for cleaning and polishing of Teflon and plastics components.
4. It is used for paint removal.
5. It is used mainly in textile and leather industries.
6. It is used in nuclear plant dismantling.

IX. CONCLUSION

In AJM, a focused jet or stream of abrasive particles carried by high pressure gas is made to impinge on the work surface through a nozzle. The metal cutting occurs due to erosion caused by the abrasive particles impacting the work surface at high speed. As a result of the impact, small bits of materials get separated from the workpiece surface. This process is capable of cutting intricate holes and shapes in materials of any hardness and brittleness.



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