Fabrication of Portable Abrasive Jet Machine

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Abstract:-*AJM (ABRASIVE JET MACHINING) is a non-traditional machining process useful for micro machining and frequently used on hardened metal. Material is removed through brittle fracture or erosion from work pieces due to high velocity of abrasive particle striking through well directed from nozzle on the work piece. In this paper the development of abrasive jet machine through easily available parts in the market, low cost and portable i.e. easily to carry anywhere.*

1.INTRODUCTION

Abrasive jet machining is a advanced machining process in which removal of material takes place from work surface by impact erosion due to high velocity jet of abrasives. The full machining process work as follows, abrasive particle are filled in abrasive feeder and pressure air from compressor is transferred through pipes in mixing chamber where abrasive particles mix with air and then it is being moved from outlet pipe which is connected to the nozzle which converts pressure energy into kinetic energy and bombards abrasive particles in work piece, upon impact abrasive particle removes material by erosion process and by brittle fracture. The purpose if AJM is quite similar to sand blasting, only cutting parameters can be controlled in AJM process. Process can be controlled to differ with the MRR which depend on flow rate and size of abrasive particles.

1.1Effect of Factors

While developing the AJM different factors are considered so that later it did not impact on machining capability of machine such as MRR, Machining accuracy.

1. Abrasive used
2. Abrasive particle size
3. Composition of air
4. Mixing ratio
5. Work piece
6. Nozzle life span
7. Stand off distance
8. Angle of nozzle tip
9. Flow rate of abrasive
10. Pressure loss during the process

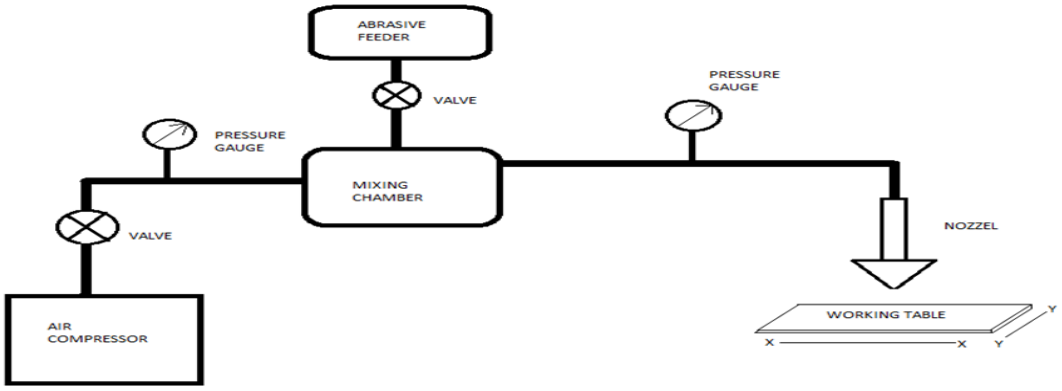

Figure 1: Schematic diagram of AJM

2. MATERIALS USED FOR AJM

2.1 Nozzle

The AJM nozzle is designed to control or manage the direction of fluid flow in this case mixture of abrasive and carrier gas. As per requirement the nozzle can be obtained in various cross sections. Nozzle is to be made of tungsten carbide or stainless steel so it can withstand wear and tear for longer life span. Nozzle convert pressure energy(PE) into kinetic energy(KE) which helps in higher velocity(100-300m/s) in the outlet point which helps in higher material removal rate. Nozzle helps in controlling jet diameter it depends on inner profile and exit diameter bigger the diameter lesser the jet velocity. Nozzle also helps in regulating the impingement angle (0^o-90^o) it's the angle between jet flow and work piece higher the angle deeper would be the cut. Nozzle used in project is Stainless Steel with inlet diameter of 6mm and outlet diameter of 0.6mm

Figure2: Nozzle

Fiqure3: Nozzle setup

2.2 Mixing Chamber

Mixing chamber is attached to two more components valve and abrasive feeder. Abrasive feeder is the part where abrasive is stored and been utilized when machine is switched on, required quantity of abrasive filled in the abrasive feeder. Valve is a device which regulates or controls the flow of the fluid it works in various passways by opening, closing, or partially obstructing. Then comes the mixing chamber where abrasive particles and carrier gas mixes and then that mixture moved forward from exit pathway, mixing chamber contains 3 nozzles or opening one with inlet of carrier gas other for abrasive particles coming from abrasive feeder and the third one for moving out the mixture of abrasive and carrier gas. In our model mixing chamber is made up of stainless steel as it has to withstand high pressure.

Figure4: Mixing chamber

2.3 Air Compressor

Air compressor is a device which converts power through electrical motor into the potential energy stored in compressed air. In AJM the air compressor is used as carrier gas and for the movement of abrasive particles to strike with high velocity in the work piece.

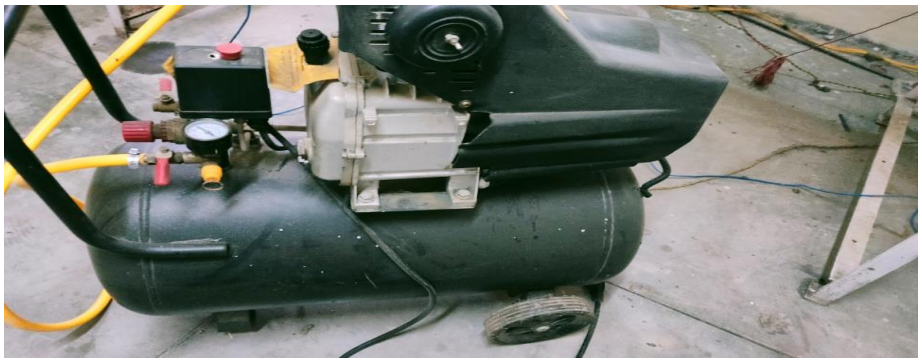

Figure5: Air compressor

Specification

Motor HP – 7.5hp, Max pressure – 175psi, Unit RPM – 1050, Tank capacity – 220litres, Weight – 275kg, Displacement – 24.7cfm

2.4 Piping System

The system which carries compressed air from air compressor to the mixing chamber and then the mixture to the nozzle. Since pressure has to be maintained throughout the process that is why nylon braided hose pipe is used fixed with screw locks at every end. We are using nylon braided hose pipe with 6mm internal diameter, it is used for long life, light weight, durable, easily available and even in bending it does not lose any pressure.

Figure6: Piping system

2.5 Work Table

Work table consist of two parts one with the bench vice and another part has an X-Y direction for the movement. Bench vice is used to grip the work piece so that while machining work piece does not make any unwanted movement. The bench vice is bolted to the fiber block which is connected to 2 lead screws which provide the moment of X-Y direction and whole system is mounted to the frame base.

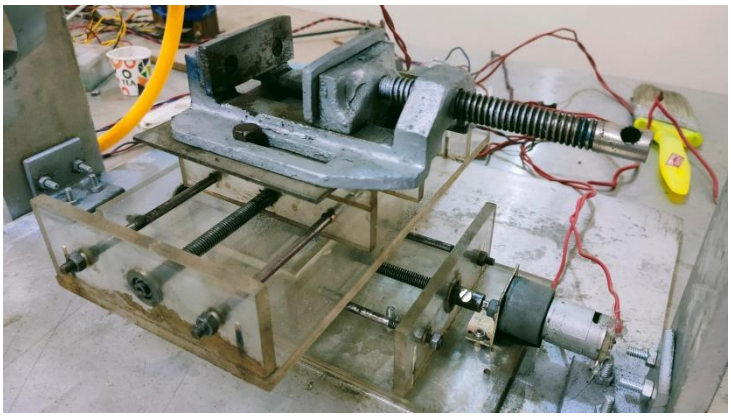

Figure7: Work table

2.6 Pressure Gauge

Pressure gauge is device which marks the amount of pressure flowing through a pipe. Two pressure gauge are used in the model one at the air compressor and another one before nozzle so that we can mark the pressure loss between the process.

2.7 Abrasive

Abrasives are the most important part of AJM, it mixed with carrier gas with high velocity to erode work piece. Major properties of abrasive are sufficient hardness, irregular shape and presence of sharp edges. Abrasive used are silicon carbide (SiC) and aluminum oxide (Al2O3).

Figure8: Abrasive(SiC)

Abrasive	Grain Size	Application
Silicon Carbide(SiC)	60 microns	Good for cleaning and cutting
Aluminum Oxide(Al2O3)	60,80 microns	Same as Al2O3 but for hard material

Table 1: Types of Abrasive

2.8 Frame

Frame is a support block where all of the above equipment are to be mounted, frames are designed in such a way so that it does not displace from its position and does not vibrate while machining. Different aluminum plate (thickness of 90mm) structures are combined or fixed with each other with stainless steel bolts for the frame build.

3. FABRICATION

Fabrication of machine consists of following parts:

Compressor, Flow Control Valves, Two Pressure Gauge, Hose Pipe, Mixing Chamber, Three Lead Screws, Three Motors, Three DPDT Switch, Nozzle, Work Table, Frame

The full fabricated model is shown in the figure below:

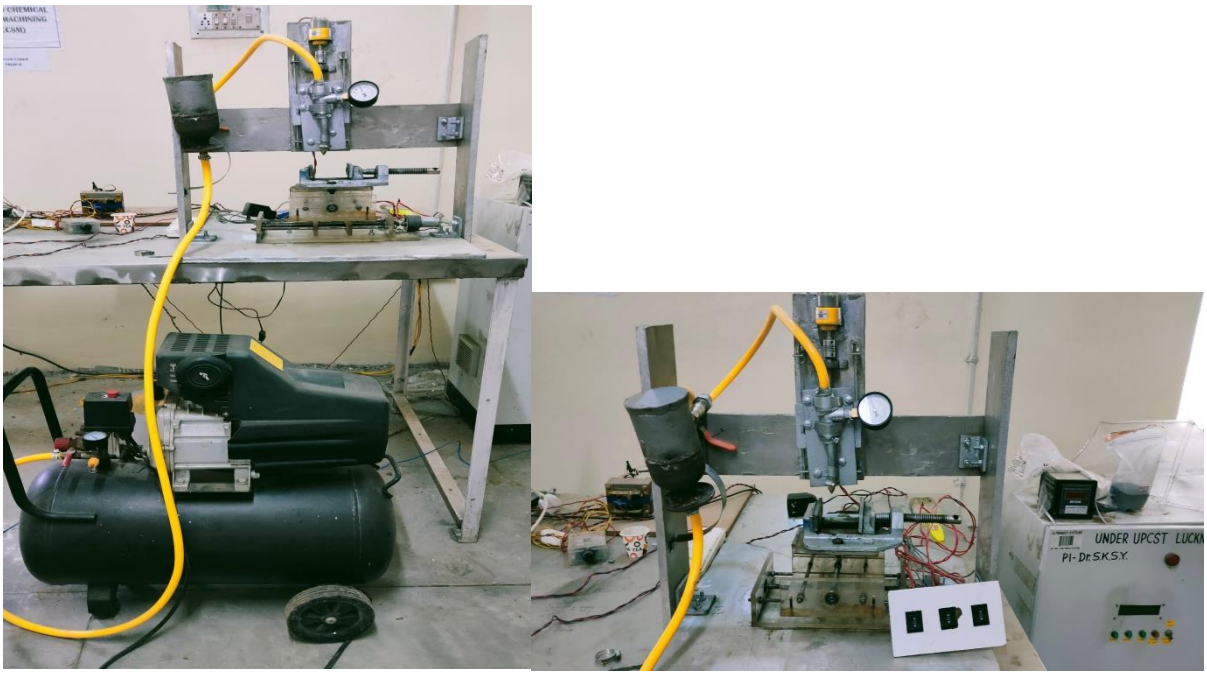

Figure9: Abrasive jet

4. FUTURE SCOPE

As by searching about AJM lots of work has be performed in past years but lot more changement and advancement yet can be performed in this method. As AJM is gaining lot of attention in advance machining process over various conventional and non-conventional machining methods, as these methods are hard and difficult to cut material such as ultrasonic, laser beam and electron discharge machining, which not only damage surface integrity but are also slow process. Very less research has been performed on improvement of abrasive flow rate or pressure loss during the process and in the design of mixing chamber for fluently of carrier gas and abrasive.

5. CONCLUSION

1. This paper consists of developing fully working prototype of AJM with low cost.
2. As all the equipment's are easily available or can easily be manufactured from simple process
3. It is portable or movable i.e it can easily be moved from one place to another
4. It can easily be automated by adding some servo motors and DC servo motors connected with PCI controllers, 2D profiles can be converted into standard G codes and M codes that can be send to machine to perform automatically.

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