International Journal of Scientific & Engineering Research, Volume ɯǿɤ(ÚÚÜÌɤɰlǿɤ# ÌÊÌÔÉÌÙɪlƔɯƛ
ISSN 2229-5518

Design and Fabrication of Abrasive Jet Machine

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Abstract— Abrasive Jet Machine is a non-conventional machining process. In Abrasive Jet Machining Process the material removal is done from the work piece with the help of high speed abrasive particles. The abrasive particle may consist of Silicon, Alumina and many more. In AJM the material remove rate is done with the help of erosion. AJM is mainly used to remove materials from brittle materials such as glass, ceramics, semiconductor and many more. The different components of abrasive jet machine are air compressor, air filter, dehumidifier, pressure regulator, mixing chamber, nozzle, horizontal and vertical motion module (xyz motion), and arrangement to hold work piece.

Index Terms: Air Compressor, Air Filter, Pressure Regulator, Mixing Chamber (Hooper), Horizontal and Vertical motion (for xyz rotation).

1 INTRODUCTION

Abrasive Jet Machining is a process of material removal by mechanical erosion caused by impingent of high speed velocity particle carried by gas or air through a shaped nozzle on the work piece. AJM is a non-traditional machine which operates materials without producing shock and heat. In AJM cutting action is cool because the carrier gas or air serves as coolant. AJM is applied for many purposes like drilling, cutting, cleaning operation.

2. Working Principle of Abrasive Jet Machine

In Abrasive Jet Machining process or gas is filtered and compressed and it is passed through the filter and compressor. Pressure regulator is provided to control the flow rate of compressed air. Compressed air is passed through the mixing chamber. In mixing chamber air and abrasives are mixed together and this mixture is sent through nozzle. The mixture comes from nozzle at high velocity which erodes or cut the material.

3. Components and Process Parameters of Abrasive Jet Machine

3.1 Abrasives

Abrasives have the property of erode the material. In Abrasive jet machine, Alumina and Silicon Abrasives of 10 to 50 microns are used.

3.2 Carrier Gas

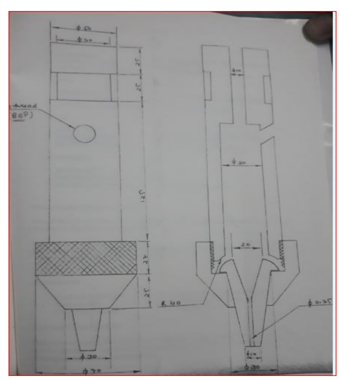
Carrier Gas air or Co_2 is mixed with abrasives and it helps to cut the material. The Density of the air is 1.3kg/$m^3$and velocity of carrier gas is 150 to 200m/s.

3.3 Standoff Distance

It is defined as the distance between face of nozzle and the working and the work piece. The standoff distance has considerable effect on material removal rate. The standoff distance between material and work piece is 5mm to 10mm.

3.4 Nozzle

Abrasive particle are directed in to work surface at high velocity through nozzle. The material of nozzle is subjected to great degree of abrasion wear and it is made of hard material Die steel. Nozzle has following components:



Part Name	Dimensions	Material Used	Material Properties
Turbulence Chamber	250 mm Length, 50 mm external dia. and 35 mm internal dia	Quenched Die Steel	Good Hardness, Low Wear Rate
Tip	55 mm in Length	Quenched Die Steel	Good Hardness, Low Wear Rate
Washers	40mm	Rubber	Airtight zero leakage

3.5 Frame

It is the most important part of AJM over which the work piece has to br kept and machined. The Travel distance of X-Y Table is 750mm*750 mm. X-Y table consists of two parts. 1st part is upper table X-slide and 2nd part lower table is Y slide. The upper table is responsible for X-movement has a travel of 750mm. The lower table has a travel 750mm and is responsible for y-motion of work piece. The different components of X-Y Table are:

Part Name	Dimensions	Material Used	Material Properties
Lead Screw	730 mm Length, 24 mm dia.	Mild Steel	High load bearing capacity
Slide Rod	820mm Length, 22mm dia.	High Carbon Steel	Centre less Grinded
Nut	70*50*50 mm	Mild Steel	Good Strength
Slider Block	120*45*45mm	Mild Steel	High Strength to Weight Ratio
Bushes	30mm dia.	Teflon	Low Friction Wear Rate

3.6 Z-Slide

Vertical Motion is required for adjusting the nozzle height or standoff distance from the work piece. The total movement of Z-slide is 200mm and material is mild steel.

3.7 Hooper

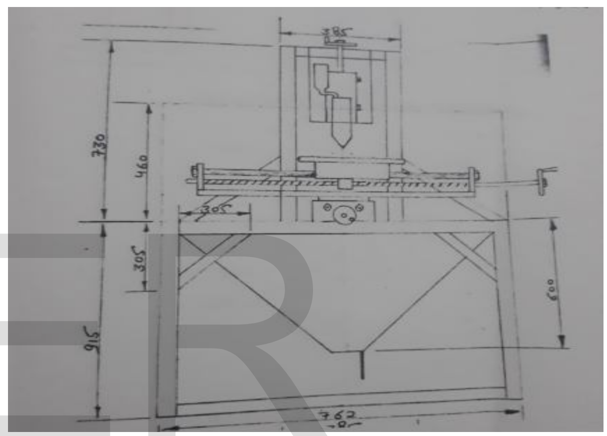
Hooper is use as a mixing chamber. The shape of hopper is cylindrical and having 750 ml. The material used for hopper is Galvanized Iron.

3.8 Dust Collector

Dust Collector collects all dust particles i.e. mixture of abrasive particles and work piece powder, so that the dust will not spread over the table and machine. The shape of dust collector is square conical and material used for it is Galvanised Iron Sheet.

3.9 Assembly

The assembly drawing of the abrasive jet machine can be represented as follows. It can be noted that the components like air compressor, dehumidifier, bellows cover and piping have been not shown in drawing.



4. Conclusion

The project can be going beyond its current position and capabilities by employing automation into it. This can done using stepper motors or DC servo motors interfaced with standard PCI controllers or stand alone controllers. 2-D profiles can be converted in to standard G-codes and M-codes that can be sent to machine to perform automated machining.

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International Journal of Scientific & Engineering Research Volume
ISSN 2229-5518

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