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INVESTIGATION OF VARIOUS PARAMETERS OF ABRASIVE JET MACHINING PROCESS .

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Abstract— Abrasive Jet Machining (AJM) or Micro Blast Machining is a non-traditional machining process, wherein material removal is effected by the erosive action of a high velocity jet of a gas, carrying fine-grained abrasive particles, impacting the work surface. The process is particularly suitable to cut intricate shapes in hard and brittle materials which are sensitive to heat and have a tendency to chip easily. As Abrasive jet machining (AJM) is similar to sand blasting and effectively removes hard and brittle materials. AJM has been applied to rough working such as debarring and rough finishing. With the increase of needs for machining of ceramics, semiconductors, electronic devices and L.C.D., AJM has become a useful technique for micromachining. Our project report deals with various experiments which were conducted to assess the influence of abrasive jet machining (AJM) process parameters on material removal rate and diameter of holes of glass plates using various types of abrasive particles. The experimental results of the present work are used to discuss the validity of proposed model as well as the other models. With the increase in nozzle tip distance (NTD), the top surface diameter and bottom surface diameter of hole increases as it is in general observation of abrasive jet machining process. As the pressure increases, the material removal rate (MRR) is also increased. The present study has been introduced a mathematical model and the obtained results have been compared with that obtained from the theoretical.

INTRODUCTION

Abrasive processes are usually expensive, but capable of tighter tolerances and better surface finish than other machining processes chances, delectability, costs and safety aspect etc. Abrasive jet machining (AJM) is a process of material removal by mechanical erosion caused by the impingement of high velocity abrasive particles carried by a suitable fluid (usually a gas or air) through a shaped nozzle on to the work piece. Common examples include Cutting, Drilling, Surface finishing, Etching, grinding, honing, and polishing The erosion phenomenon in an AJM study may be considered in two phases. The first phase consists of transportation problem, that is, the quantity of abrasive particles flown, and the direction and velocity of impinging particles as determined by the fluid flow condition of solid-gas suspension. The second phase of the problem is the determination of the material removal rate or the erosion rate.

The erosion of a surface by impacting solid particles is a discrete and accumulative process. Hence, the models are first made on the basis of a single particle impact. The mechanism of erosion in such cases is complex, involving mechanical, chemical and material properties.

The erosion is a function of several variables such as

a) Speed and angle of impact;
b) Ductility and! or brittleness the impinging particles;
c) Elasticity of the material; of the material and
d) Shape and geometry of impinging particles;
e) Impinging particle diameter to work-material, thickness ratio;
f) Average flow stress;
g) Material and density; and
h) Distance between the nozzle mouth and work piece

1.1 Process parameters of AJM

1.1.1 Carrier Gas (Medium):

a. Carbon dioxide,
b. Nitrogen,

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c. air.
Air is most widely used. But oxygen never used as a carrier gas due to fire hazards.

1.1.2 Abrasive:
Abrasives are available in many sizes ranging from 10 micron to about 1.3 mm. the smaller sizes produce a finish cut and are suitable for polishing, cleaning and grooving.
The larger sizes are more suitable for cutting and peening because of their faster cutting action.

a. Alluminium oxide suitable for cutting, grooving and debarring operations.
b. Silicon carbide used for similar operation but for harder material.
c. Sodium bicarbonate is useful for light duty work like cleaning, cutting and debarring for soft materials.
d. Dolomite also is suitable for fine etching or polishing work only.
e. Glass beads can be used for polishing surface to a matte finish and debarring work.

1.1.3 Velocity of abrasive: The jet velocity is a function of nozzle pressure & design. The range of jet velocity is 150-300 m/min.

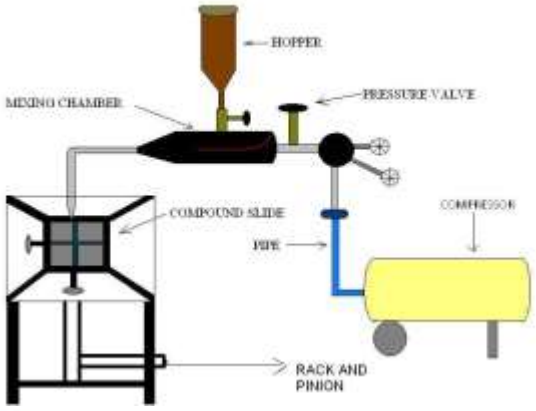
1.1.4 Work Material: It is recommended for processing of hard, brittle, and glass sheets material.

1.1.5 Nozzle: AJM nozzles generally made of WC or Sapphire to resist abrasive wear due to the high velocity abrasive stream. The nozzle have either a right angled or straight edge shape.

Characteristics of different parameters

Medium	Air , CO_2 ,N_2
Abrasive	SiC, Al_2O_3 (of size 20μ to 50μ)
Flow rate of abrasive	3 to 20 gram/min
Velocity	150 to 300 m/min
Pressure	2 to 8 kg/cm2
Nozzle size	0.07 to 0.40 mm
Material of nozzle	WC, Sapphire
Nozzle life	12 to 300 hr

Experimental Set-up



The compressed air from the compressor enters the mixing chamber partly prefilled with fine grain abrasive particles. The vortex motion of the air created in the mixing chamber carries the abrasive particles to the nozzle through which it is directed on to the work-piece. The nozzle and the work-piece are enclosed in a working chamber with a Perspex sheet on one side for viewing the operation

The abrasive particles used were SiC (grain size 60 microns and 120 microns). The nozzle material was stainless steel and the nozzles used were of diameters 1.83 mm and 1.63 mm.
This type of set-up has the advantage of simplicity in design, fabrication and operation. The equipment cost is much less except the compressor. The mixtureratio is controlled by the inclination of the mixing chamber

These investigations indicate that after a threshold pressure, the MRR and penetration rates increase with nozzle pressure. For brittle materials, normal impingement results maximum MRR and for ductile materials, an impingement angle of 15-20 degrees results in maximum MRR. The effects of abrasive grit size and mixing ratio which is the ratio of the weight of the abrasive powder to the weight of the abrasive powder and the air have been thoroughly investigated by many investigators. As the abrasive grit size and mixing ratio increase, the MRR and penetration rate increase but the surfaces finish value which is measured in Ra decreases.

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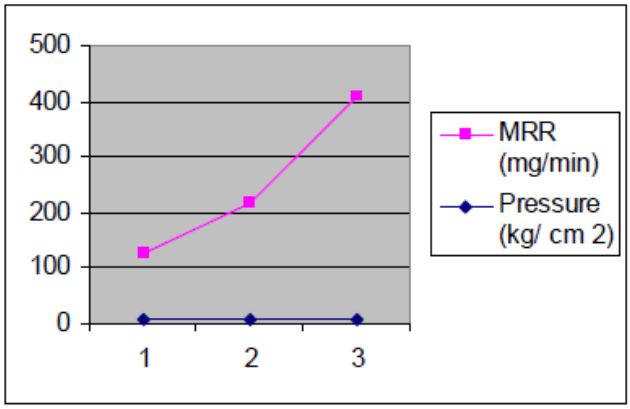
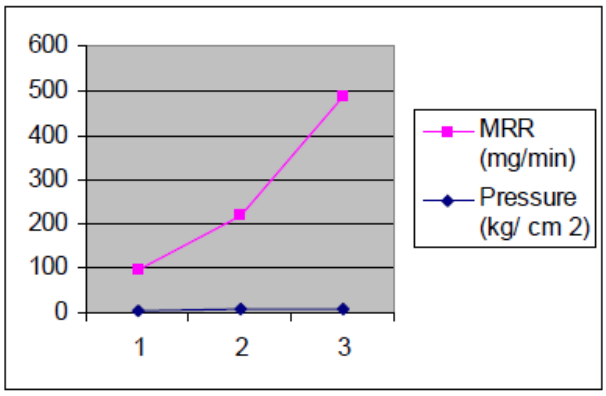
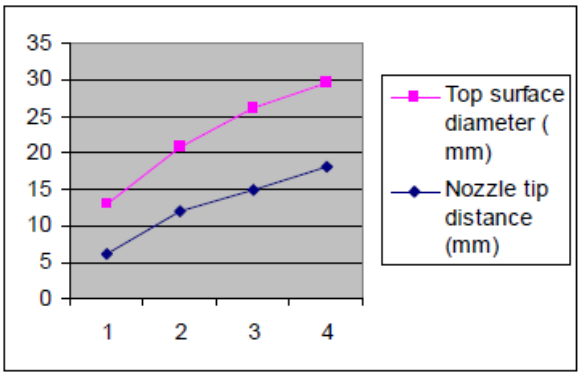


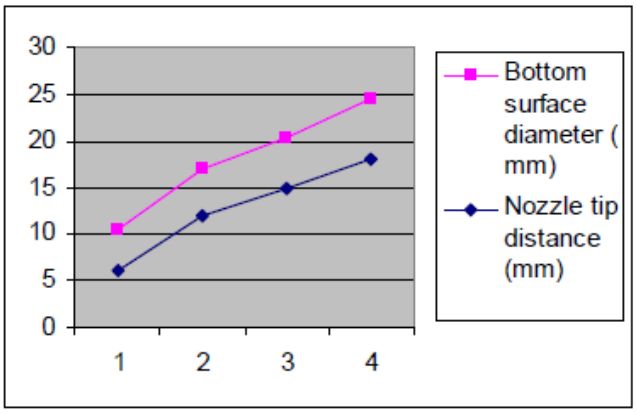
Graph Shows TheRelationship Between Pressure And Material Removal Rate (MRR) At Thickness 8 mm And NTD 12 mm



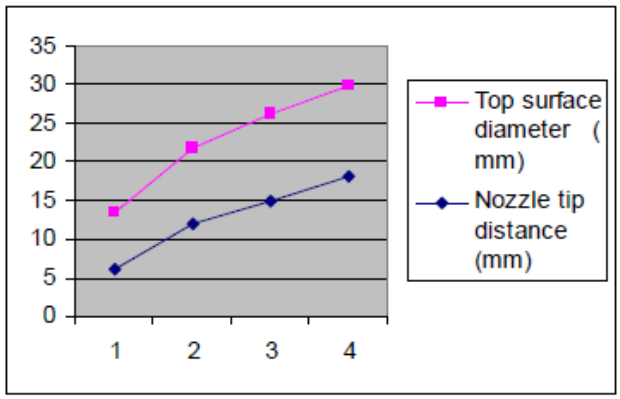
Graph Shows TheRelationship Between Pressure And Material Removal Rate (MRR) At Thickness 12 mm And NTD 12 mm



Graph Shows The Relationship Between Nozzle Tip Distance And Top Surface Diameter Of Hole At A Set Pressure Of 5.5 Kg/ cm^2



Graph Shows The Relationship Between Nozzle Tip Distance And Bottom Surface Diameter Of Hole At A Set Pressure Of 5.5 Kg/ cm^2



Graph Shows The Relationship Between Nozzle Tip Distance And Top Surface Diameter Of Hole At A Set Pressure 6.5 Kg/ cm^2

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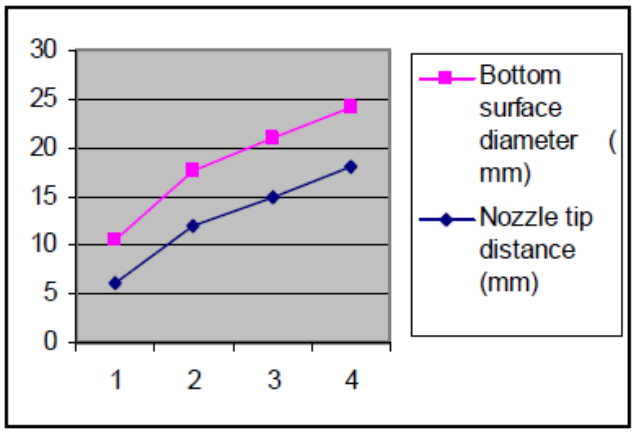
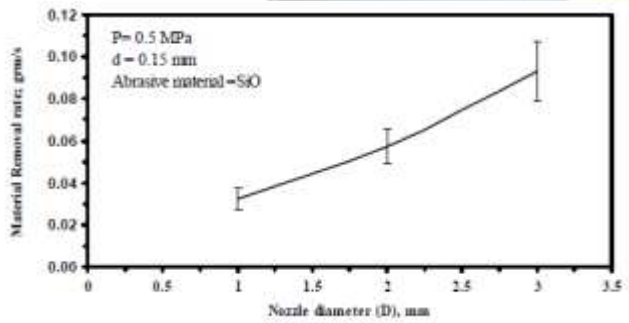


Graph Shows The Relationship Between Nozzle Tip Distance And Bottom Surface Diameter Of Hole At A Set Pressure 6.5 Kg/ cm^2



Effect Of Nozzle Diameter (D) On The Material Removal Rate Of The Glass

It is very clear that AJM is greater Non-conventional machining process which is used as a multipurpose system. It is also a most effective among various affordable systems. This system is eco-friendly. Even some of the companies in India like ABB, L & T and ESSAR are already using this system with CNC programming. This system is also use as Water Jet Machining (WJM) in whichabrasives such as garnet, diamond or powders can be mixed into the water to make slurry with better cutting properties than straight water. Further development in WJM is called Hydrodynamic Jet Machining (HJM) which combines the principle of Water Jet Machining and Abrasive Jet Machining process. AJM is also used as Abrasive Flow Machining (AFM), Ultrasonic Machining (USM).

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