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Influence of Process Parameters on Kerf In Abrasive Jet Drilling of Glass

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Abstract— Grating Jet Machining is a rising innovation with particular points of interest over the other non-customary cutting advances, for example, high adaptability, , high machining flexibility least weights on the work piece, no warm twisting and less cutting powers. Rough Jet Machining is a micromachining procedure where the metal evacuation happens because of disintegration of High speed abrasives conveyed in a vehicle of gas, by and large air. This procedure is adequately utilized for hard and fragile material like Glass, Ceramics, and Composites and so forth. This paper researches the impact of procedure parameters on width of cut of Glass example. There are various related parameters in this machining procedure. They are gaseous tension, Nozzle breadth, standoff separation, sway edge, spout length, grating mass stream rate, rough molecule size, grating molecule shape and rough molecule hardness. Among these parameters Air Pressure, Nozzle width, Stand of separation, Abrasive stream rate are of incredible significance however decisively controllable. The Performance measures incorporate Depth of cut, kerf width, Surface unpleasantness and Metal evacuation rate. In this paper Kerf width (Top and base kerf width) is considered as execution measure and the Process parameters considered are Pressure, SOD, Abrasive Mass stream rate and Nozzle distance across.

Keywords— Erosion rate, stand of distance. Material removal rate. Glass. Process parameters

I. INTRODUCTION

Rough fly machining (AJM) is an Un Conventional Machining Process in which expulsion of material happens through the activity of impingement of fine grating particles in a high-speed gas stream. This procedure is likewise alluded to as "pencil impacting" or "smaller scale rough impacting". Miniaturized scale grating particles are moved by inactive gas at speeds of 150 to 300 m/sec. At the point when coordinated at a work piece, the outcome in disintegration can be utilized for cutting, scratching, cleaning, deburring, cleaning, and penetrating. Material evacuation happens through a chipping activity, which is particularly viable on hard, weak materials, for example, glass, silicon, tungsten, and earthenware production. Delicate, strong materials, for example, elastic and a few plastics oppose the chipping activity and in this way are not successfully handled by AJM (1,3). This procedure is inalienably liberated from gab, vibration, and warmth issues on the grounds that the device never contacts the substrate. This procedure is utilized in an enormous assortment of utilizations extending from slicing to cleaning.

The gas supply pressure is on the request for 850 kPa (125 psi) and the stream speed can be as high as 300 m/s and is Constrained by a valve . Average cutting rates differ between 25 - 125 mm/min. The dimensional Tolerance Typical extents ± 2 to ± 5 µm (5) . The Surface Finish Typical Ra esteems shift from 0.3 - 2.3 µm.

Rough fly machining (AJM), likewise called pencil or sand impacting, is a Non-Traditional machining process in which uses a high-pressure air stream conveying Micro Abrasive particles to encroach the work piece surface for material evacuation and shape age. AJM vary from the ordinary sand shooting process in the manner that the rough is a lot better and compelling command over the procedure parameters and cutting(8). Utilized for the most part to cut hard and weak materials, which are dainty and delicate to warm. The metal expulsion happens because of the disintegration of the rough particles striking the work piece surface. AJM has constrained material evacuation capacity and is regularly utilized as a getting done with, cleaning and deburring process. The Physics of this procedure is first Fine Abrasive particles (0.025mm) are quickened in a gas stream(3) . The rough grains are then coordinated towards the core interest of machining. As the particles impact the surface, they fracture off the work surface. The gas stream carries both the abrasive particles and the fractured (wear) particles away. This process is Good for difficult to reach area.

The work piece material will be expelled by the activity of mechanical scraped area of the high speed rough particles. The material evacuation rate is for the most part subject to the stream rate and size of the rough particles. High grain size will consistently deliver increasingly metal evacuation. At a specific weight the material evacuation rate increments with the grating stream rate however in the wake of arriving at an ideal worth, the material expulsion rate diminishes with the further increment in rough stream rate(12). This is because of the way that mass stream pace of the gas diminishes with the expansion of rough stream rate and subsequently the blending proportion expands causing a decline in material expulsion rate in view of the diminishing vitality accessible for disintegration. The grating particles are commonly not utilized over and over for example reuse of abrasives are not liked. Development of Abrasive fly machine is simple as a result of Low capital expense.

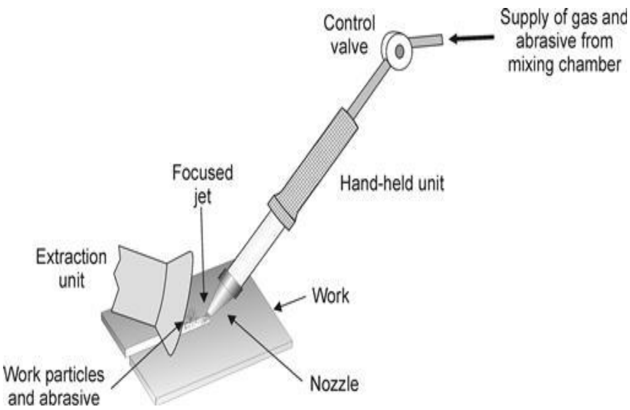

Fig 1 : Abrasive Jet Machining

A grating is a little, hard molecule having sharp edges and an unpredictable shape. Abrasives are fit for evacuating limited quantities of material through a cutting procedure that produces modest chips. Different sorts of rough particles with various sizes utilized in Abrasive Jet Machine are Aluminum oxides, silicon carbides, Crushed glass, Sodium bicarbonate, Dolomite. Aluminum oxide, Aluminum oxide is a concoction compound of aluminum and oxygen with the substance recipe Al2O3.one of the most regularly utilized materials, is utilized to perfect, cut and deburr.The other promising rough is Silicon carbide otherwise called carborundum, is a compound of silicon and carbon with synthetic equation SiC(7,9,12).

II. EXPERIMENTAL WORK

Glass is the Material utilized as work material because of its homogeneous properties. A general definition for Glass is a shapeless strong material that shows a glass progress, which is the reversible change in undefined materials from a hard and moderately weak state into a liquid or elastic like state(4). The test examples were cut into square and rectangular shape for machining on AJM unit having various thicknesses. In machine the underlying loads of glass examples were estimated with the assistance of advanced balance(11,13). In the wake of machining the last loads were estimated with the assistance of advanced parity to compute the material expulsion rate.

III. METHODOLOGY

Experiments were conducted to confirm the effect of process parameters on width of cut of glass machined by AJM. The experimental work was carried on a test rig which was designed and manufactured in the workshops of the Mechanical Engineering Department, St Martin's Engineering College. The type of abrasive used for these experimentation Aluminium Oxide (Al2o3). Several Nozzles were made with different bore sizes (2,3,4mm), Tungsten was used as the nozzle material. Drilling was performed by setting the important parameters. The list of parameters used are indicated in Table 1.

Table 1: Parameters and the details of operational parameters

Abrasives	
Type	Al_2O_3 or SiC (used once)
Size	Around 25 μm
Flow rate	3–20 g/min
Medium	
Type	Air or CO_2
Velocity	150–300 m/s
Pressure	2–8 kg/cm^2
Flow rate	28 L/min
Nozzle	
Material	Tungsten carbide or sapphire
Shape	Circular, 0.3–0.5 mm diameter
	Rectangular (0.08 × 0.51 mm to 6.61 × 0.51 mm)
Tip distance	0.25–15 mm
Life	WC (12–30 h), sapphire (300 h)
Operating angle	Vertical to 60° off vertical
Area	0.05–0.2 mm^2
Tolerance	±0.05 mm
Surface roughness	0.15–0.2 μm (10-μm particles)
	0.4–0.8 μm (25-μm particles)
	1.0–1.5 μm (20-μm particles)

Fig 2 : AJM Set-Up at SMEC

IV. RESULTS AND DISCUSSION

By examining the test information, it has been discovered that the impacts of the four fundamental parameters, i.e., Air pressure, grating mass stream rate, spout measurement and spout standoff separation on the kerf width are in a similar manner as revealed in past investigations for glass and different materials. The impacts every one of these parameters is contemplated while keeping different parameters considered in this investigation as consistent.

Effect of Air pressure on Kerf Width

The impact of water pressure on the profundity of cut is appeared in Fig. 3 & 4. Results demonstrate that inside the working reach that if the pneumatic stress builds the Top kerf width and base Kerf width will increment by keeping the Nozzle diameter, NTD,Abrasive mass stream rate as consistent (2).When gaseous tension is expanded the fly motor vitality likewise builds which prompts High width of cuts. The idea of increment in gaseous tension will in general increment in Metal expulsion rate is additionally material in width of cut.

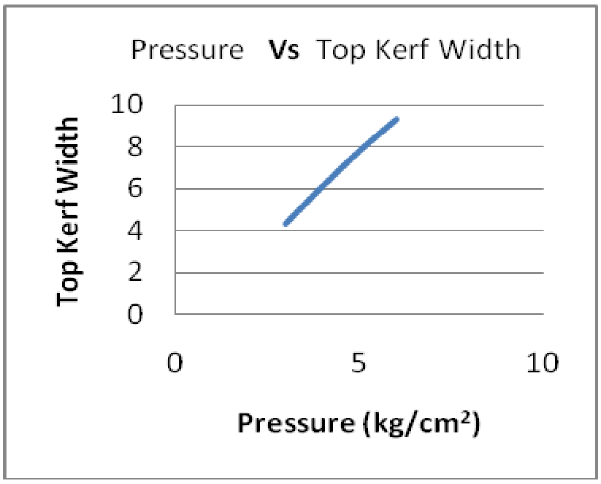

Fig 3 :Air pressure versus Top kerf width

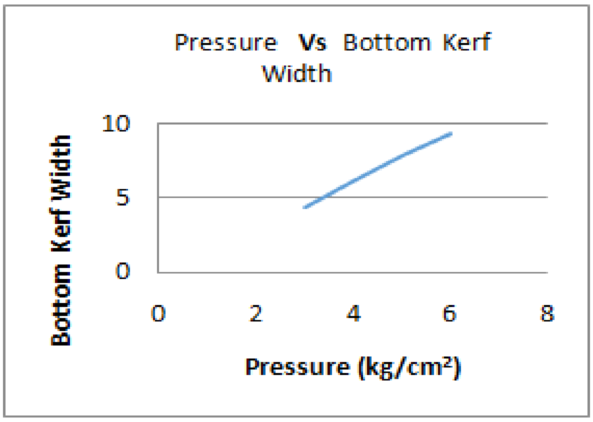

Fig 4 :Air pressure versus Bottom kerf width

Effect of Standoff Distance on Kerf Width

Standoff separation is the separation between the spout and the work piece additionally called as Nozzle tip separation, during cutting activity If we keep other operational parameters steady, when standoff separation expands, Top and Bottom Kerf widths diminishes. This is appeared in Fig.5 & 6.However standoff separation on profundity of cut isn't a lot of compelling when contrasted with different parameters which are altogether considered in this investigation.

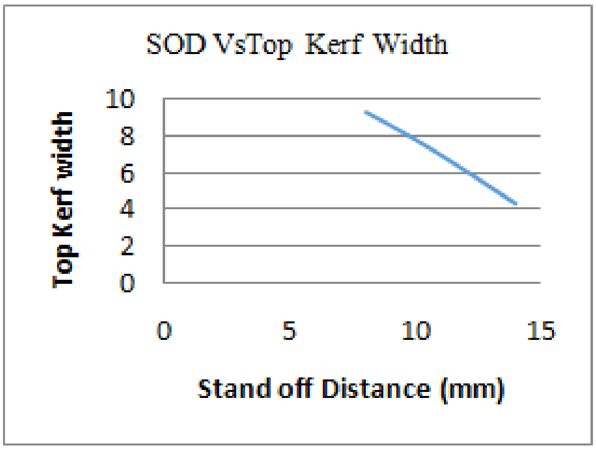

Fig 5 : SOD versus Top kerf width

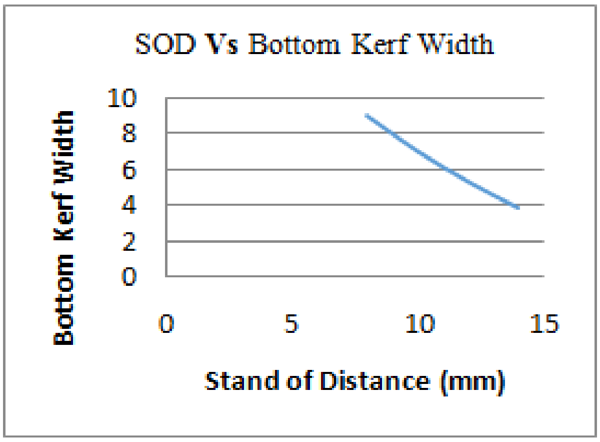

Fig 6: SOD versus Bottom kerf width

Effect of Abrasive Mass Flow Rate on Kerf Width

Increment in grating mass stream rate additionally expands the profundity of cut as appeared in Fig. 7 & 8. This is found by keeping different parameters like Air Pressure, NTD, and Nozzle width as steady. The effect between the rough molecule and the material to be machined decides the capacity of Abrasive Jet to cut the material. The mass stream pace of the grating particles incompletely decides the recurrence of rough grains and halfway decides the speed at which they hit. With the high mass stream rate the motor vitality of air will impact on particles because of this the width of cut will be more at top surface and similarly less at base surface. At low mass stream rate It is accepted that the particles don't slam into each other and, consequently, they hit the material with a greatest speed and most extreme conceivable dynamic vitality. AS the Mass stream rate expands a portion of the grating particles will crash into one another, subsequently, losing active vitality and bringing about lower speed impacts when hitting the material(4). On the off chance that rough mass-stream rate goes up the molecule speed goes down. The Abrasive mass stream rate is subject to numerous parameters, for example, the pneumatic force, the spout breadth, and the mass-stream pace of air. Mass stream pace of the gas (or air) in rough fly is contrarily relative to the mass stream pace of grating particles.

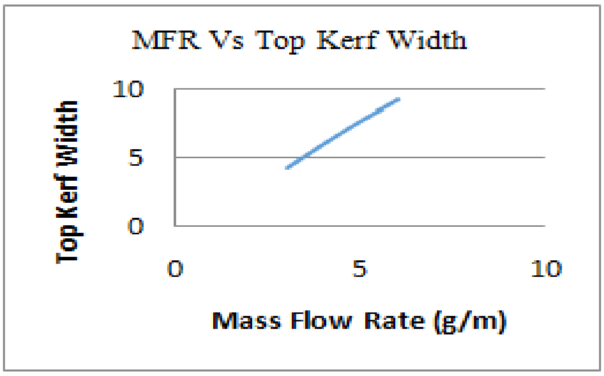

Fig 7: Mass flow rate versus Top kerf width

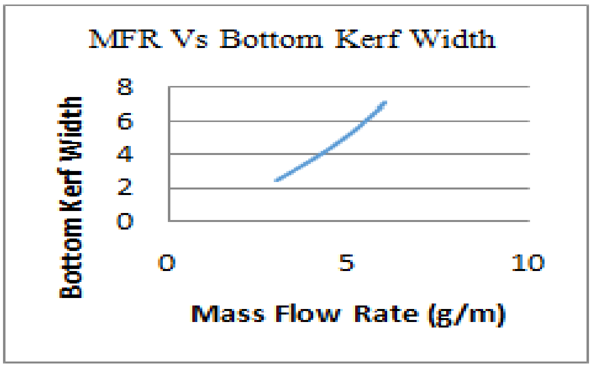

Fig 8: Mass flow rate versus Bottom kerf width

V. CONCLUSION

In the present study, abrasive jet drilling of glass has been experimentally investigated for cutting depth. The effects of various operating parameters such as air pressure, SOD, abrasive mass flow rate, nozzle diameter have been studied. As a result of this study, it has been observed that these operational parameters have a direct effect on width. It can also be concluded that abrasive jet machining with aluminum abrasive is suitable for hard and brittle materials such as glass and fiber glass. It can also be concluded that in processes that have the importance of removing the material, the stand-off distance should be kept optimal, coarse-sized abrasive should be used and high pressure employed. In addition there is great scope for researchers to study the effect of process parameters on other performance measures, mathematically; Regression modeling of this process can be developed with the help of various software.

Fig 9: Glass specimens which are machined by Abrasive Jet Machining

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