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Development and Fabrication of Portable Abrasive Jet Machine

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Abstract: Abrasive jet machine is the material removal operation where the material is removed or cut by high velocity stream of air, gas or water and abrasive mixture. The abrasive jet machining (AJM) is a process of non-traditional machine which operators on no physical contact between tool and work piece. The abrasive jet machining can be seemly employed for machining super alloys and refractory form material. The process is also very much seemly for cutting, cleaning, grooving, finishing and debarring operations of hard and brittle materials such as glass, ceramics and mica. There is no restriction to material to be machined. Thus it cuts conductive as well as non-conductive materials. In this research work, portable abrasive jet machine was developed using 2D drawings and 3D model with the help of software's. The developed 2D drawings and 3D model were further used for fabricating prototype machine model. The fabricated portable abrasive jet machine has produced precise holes on glass material more efficiently.
Keywords: Glass, Abrasive Jet Machine, Hole diameter, Material removal rate, 3D model

I. INTRODUCTION

In recent years various non-traditional of manufacturing process have been invented for solving the machining problems of hard to machine and brittle materials. The Abrasive Jet machining (AJM) is the one of the technique of non-traditional machining process. The material is cut by high velocity stream of air, water, gas, and abrasive mixture. In this process, there is no physical contact between tool and workpiece. The abrasive jet cutting is used in the cutting of materials like; Glass, Composites, Plastics, Ceramics Titanium, Brass, Aluminum, Stone, Any Steel, Tungsten carbide etc. The abrasive jet machining can be appropriate utilized for machining super alloys and refractory type material [1, 2]. In this process the material is removed from the work piece because of the impingement of fine grained abrasive by high velocity gas stream. The stream of abrasive mixed with air and which is directed to the workpiece by suitably designed nozzles.

The process differs from conventional sand blasting. In that abrasive particles used are finer and the process parameters and cutting actions is carefully controlled. The process is free from chatter problems and vibrations. The process criteria are greatly influenced by various process parameters as enumerated below:

A) Abrasives: composition, Shapes, Size and flow rate of abrasive.

B) Carrier Gas: Pressure, Weight, flow rate of carrier gas, Viscosity, Molecular, etc.

C) Nozzle: Orientation with Horizontal and stand-off distance, geometrical features and material for construction [3-7].

In this research paper explaining the development and fabrication of portable jet machine which is further used for trial experimentation on glass material.

The glass has various excellent properties such as low thermal and electrical conductivity, transparent, superior optical, improved strength high chemical resistance, high specific strength, heat-resisting capacity, high corrosion resistance, hydrophilicity, anisotropic properties excellent mechanical hardness, excellent anodic bonding property, and its good surface quality. Therefore it is widely used in various engineering and biomedical fields. The various applications as micro-electromechanical systems, mechanical inertial sensors, micro fabricated devices like oxide fuel cells and micro-pumps, optical telecommunication, optical industries for spectacle lenses and optical instruments, miniaturization of microfluidic devices for chemical and biological micro total analysis systems [8, 9].

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II. BASIC WORKING PRINCIPLE

The operating working principle of the process is very simple which is shown in figure 1. The high pressure air from the compressor passes over filters and control valves into a mixing chamber. The abrasive particles and carrier gas are meticulously mixed in the mixing chamber and a stream of abrasive mixed gas passes through a nozzle on the workpiece. Therefore, it reasons indentation on the workpiece. The indentation eventually results in rupture of particles from the work surface. The size of grit, the abrasive, nozzle geometry and its inclination used for cutting, the carrier gas pressure and the velocity are utilized as criteria for evaluating AJM process. A high velocity jet having abrasive particles is focused on to the work surface through the nozzle. The nozzle has to sustain maximum wear because of abrasion. The accuracy of cutting and the metal removal rate be influenced by the nozzle wear. The material utilized for nozzle is high wear resistance. In this process the nozzle are made of tungsten carbide or sapphire having regular round or square hole [10-13].

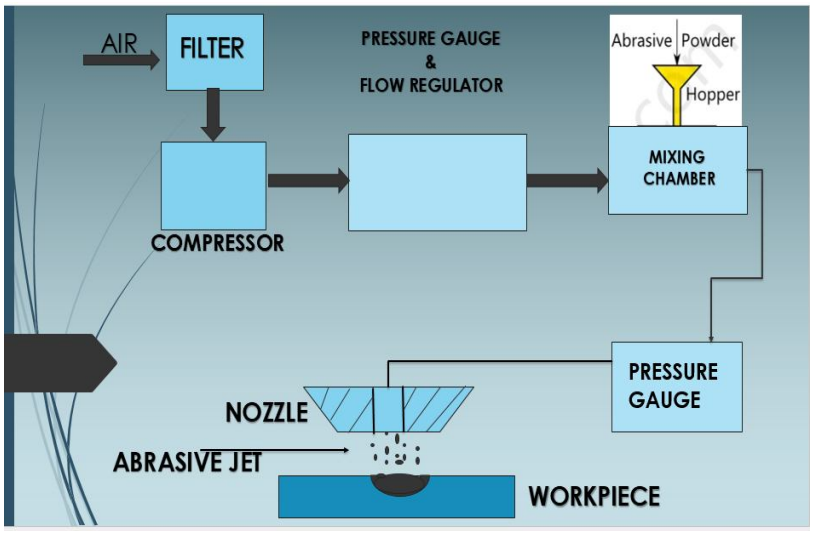


Fig. 1. Woking principle of abrasive jet machine

III. DEVELOPMENT AND FABRICATION OF ABRASIVE JET MACHINE

The portable abrasive jet machine is fabricated by using 2D drawings and 3D model. The Autocad software was used for developing 2D drawings and Catia software was used for developing 3D model of abrasive jet machine. The portable abrasive jet machine was successfully developed and fabricated with the help of these drawings and models of abrasive jet machine. Figure 2 shows a 3D model of portable abrasive jet machine and figure 3 shows fabricated portable prototype model of abrasive jet machine.

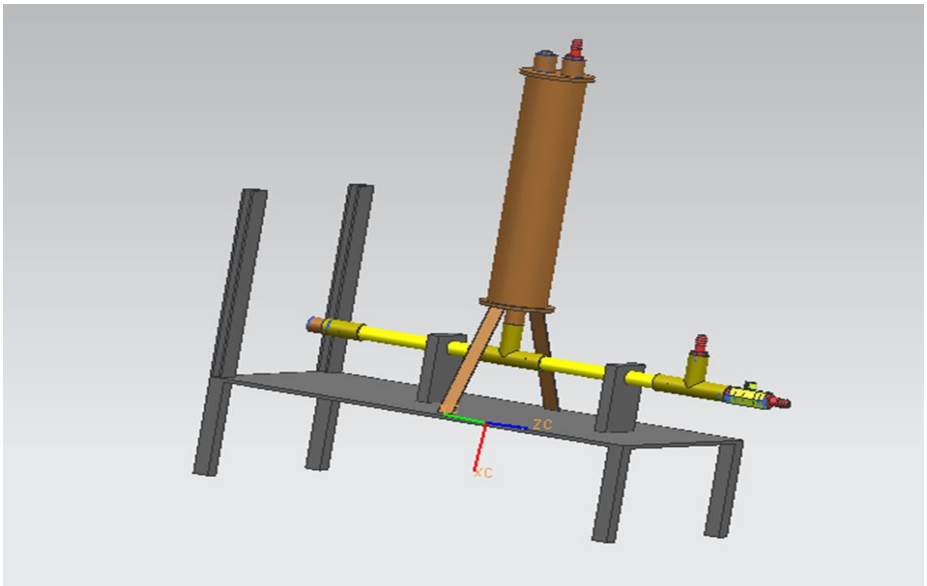


Fig. 2 3D model of portable abrasive jet machine

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Fig. 3 Fabricated portable abrasive jet machine

IV. EXPERIMENTAL TRIALS

The abrasive jet machine is carried by high pressure and high velocity which is used to impinge on the work interface. This eliminates tool to metal contact, which are the main criteria of unconventional machining method used in this machining process. The parameters which affect the material removal of the workpiece are abrasive particle size and type, standoff distance, mass flow rate of abrasive, nozzle diameter, abrasive jet velocity and carrier gas pressure. The carrier gas attains a maximum velocity at the exit of the nozzle, but abrasive particles being heavier than air tend to lag behind and attain maximum velocity at some distance away from the nozzle exit. Therefore, it is seen that material removal rate increases with an abrasive flow rate. The grain size of abrasive reduces the stand of distance at which material removal occur increases slightly. This fact is because of increase in density of the finer abrasive particles than courses particle [1, 3, 14-15]. Figure 4 shows the experimental conditions during AJM and figure 5 shows the machined holes on glass material using AJM.



Fig. 4 Experimental conditions

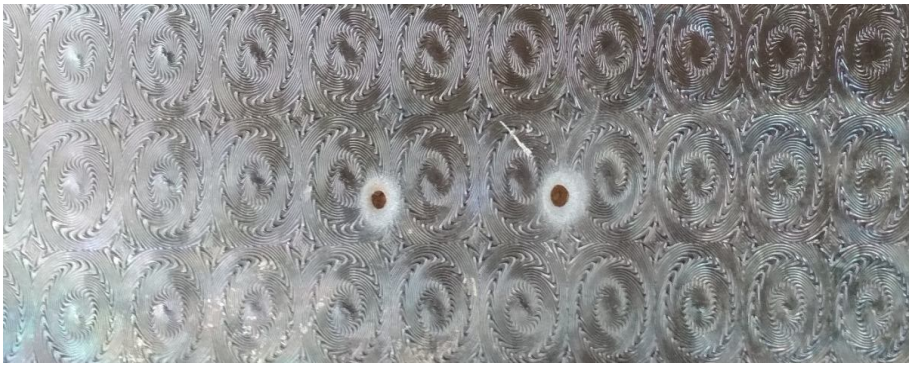


Fig. 5 Machined holes on glass material using AJM

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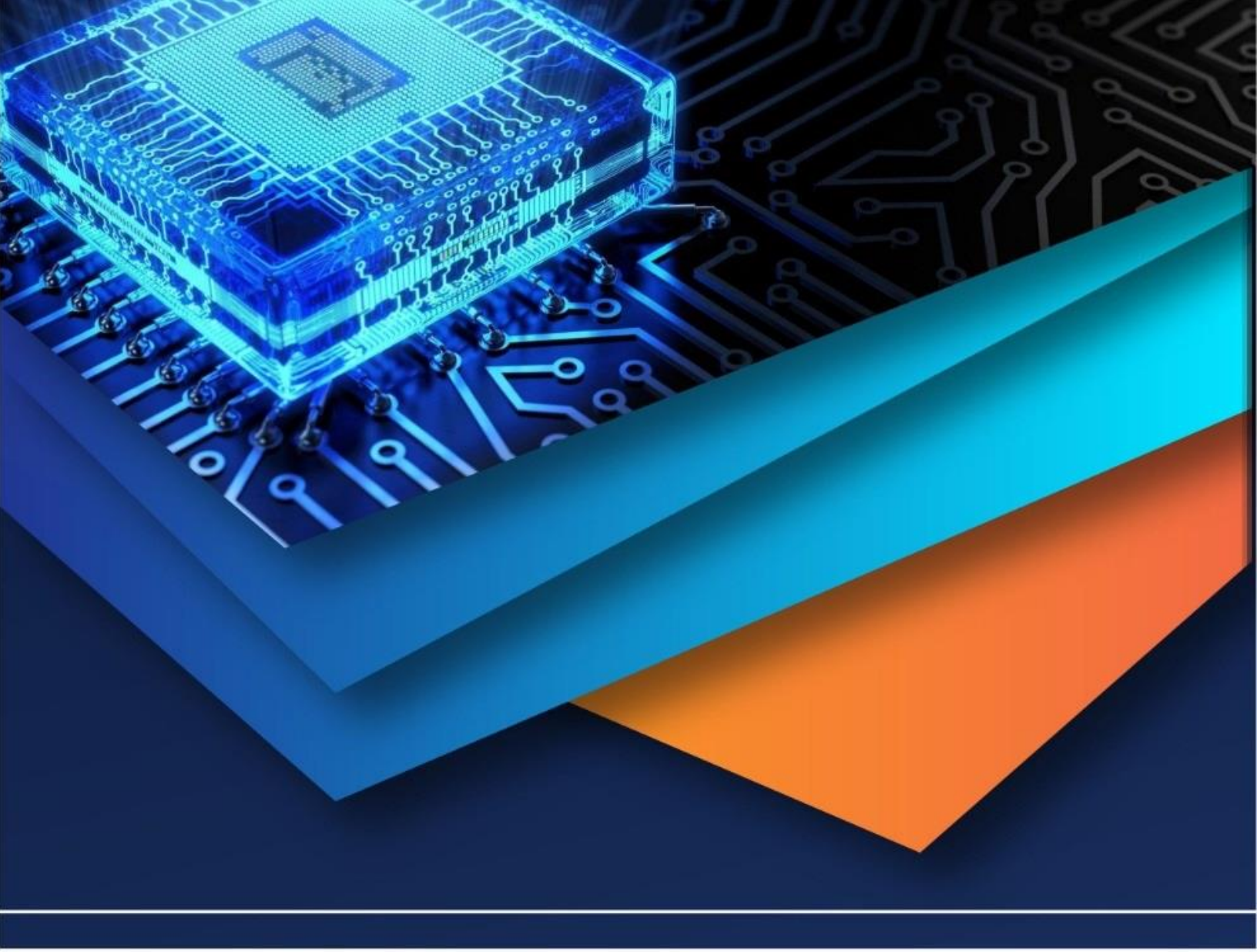
V. CONCLUSION

The portable abrasive jet machine was developed and fabricated with the help of drawings and CAD model. This machine has successfully produced holes on glass material which is brittle and hard in nature. The precise holes were produced on glass material efficiently. This machine can be useful for machining of conducting as well as non-conducting materials. The low cost abrasive jet machine can be useful for industrial applications. The material removal rate increases with increase in abrasive flow rate. The Sic abrasives give more material removal rate and perfectly round holes on glass surface. In future with slight modifications, AJM will become important machine tool on shop floor. There is scope for future work are study of nozzle wear, study of characteristic of abrasive particles, dimensional analysis for calculating theoretical metal removal rate.

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