Design and Fabrication of Pneumatic Mirror Holing Machine

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Abstract - *Glass hole making Machine presents the working of abrasive jet machining and removing the materials from brittle and heat sensitive materials by the application of high speed stream of abrasive particles carried by a gas medium through the nozzle. In particular drilling of holes minimum diameter and maximum depth is also possible with greater accuracy and surface finish. Since no heat is induced while machining the surface, and also the workplace is not subjected to thermal shocks. The machine which has been fabricated is used for making holes and cutting materials like glass, ceramics and aluminum sheets by varying the parameters like pressure, nozzle tip distance and size of abrasive and flow rate. It can be noted that the machine was designed and fabricated under the working principle of JM for making holes and cutting glass.*

Key Words: Glass Hole making machine, JM, Abrasive, Cutting, Ceramics.

1. INTRODUCTION

Rapid technology development in the field of new materials and alloys with increasing strength, hardness, toughness, heat resistance and wear resistance have imposed many problems and difficulties during the machining by conventional means. Machining intricate and complicated shapes of this and fragile components and accurate and economical forming of very hard, high strength materials which are being extensively used in Aero plane and nuclear industries have forced the scientist, engineers and technologists to search for new techniques of machining which can readily provide an effective solution to these problems. As a research and development for the last forty years several new methods of machining have emerged. Among the new methods we are going to deal with the abrasive Jet Machining. The conventional techniques like turning, drilling, milling etc., are well known and involves the use of mechanical power between the work piece and the whereas in this method need not be the case with unconventional on advanced machining techniques.

2. LITERATURE REVIEW

Holing of glass sheets with different thicknesses have been carried out by abrasive jet Machining process (AJM) in order to determine its mach inability under different controlling parameters of the AJM process. The present study has been introduced a mathematical model and the obtained results have been compared with that obtained from other models published earlier. The experimental results of the present work are used to discuss the validity of the proposed model as well as the other models by H.M. Abd E1- Hafez, and M.A. Shaker.

A machining operation is basically a material removal process, where material is removed in the form of chips. In a machining operation, the output parameter is achieved by controlling various input parameters. This paper discusses the effects of various input parameters in abrasive Jet machining (AJM) on the material removal rate (as the output parameter). The results presented in the paper are obtained from an experimental study arrived out with an AJM unit with vortex type mixing chamber. The study was restricted abrasive jet drilling only by P K Ray, Dr A K Paul. Surface roughness and kerf taper ratio characteristics of an abrasive water jet machined surfaces of glass/epoxy composite laminate were studied. Taguchi's design of experiments and analysis of variance were used to determine the effect of machining parameters. Hydraulic pressure and type of abrasive materials were considered as the most significant control factor in influencing Ra and TR, respectively. Due to hardness of silicon oxide type of abrasive materials, it performs better than garnet terms of both machining characteristics. Increasing the hydraulic pressure and abrasive pass flow rate may result in a better machining performance for both criteria. Meanwhile, increasing the standoff distance and traverse rate may improve both criteria of machining performance. Cutting orientation does not influence the machining performance in both cases. So, it was confirmed that increasing the kinetic energy of abrasive water jet machining (AWJM) process may produce a better quality of cuts by M.A. Azmira, A.K. Ahsanb.

Abrasive jet machining (AJM), a specialized form of shot blasting using fine-grained abrasives, is an attractive micro-machining method for ceramic materials. In this paper, the mach inability during the AJM process is compared to that given by the established models of solid particle erosion, in which the material removal is assumed to originate in the ideal crack formation system. However, it was clarified that the erosion models are not necessarily applicable to the AJM test results, because the relative hardness of the abrasive against the target material, which is not taken into account in the models, is critical in the micro-machining process. In contrast to conventional erosion by large-scale particles, no strength degradation occurs for the AJM surface, which is evidence that radial cracks do not propagate downwards as a result of particle impacts. 2002 Elsevier science Inc. by M. Wakuda Y.Yamauchi , S. Kanzki

Experimental investigations were conducted to assess the influence of abrasive jet machining (AJM) process parameters on surface roughness of glass fibre reinforced poxy composites. The approach was based on Taguchi's method and analysis of variance optimize the AJM process parameters for effective machining, it was found at the type of abrasive materials, hydraulic pressure, standoff distance and traverse rate were the significant control factors and the cutting orientation was the insignificant introlfactor in controlling the noise factors effect, the forms of glass fibers and iciness of composite laminate showed the greatest influence on surface roughness. A mathematical model was developed using piecewise linear regression analysis to predict performance of Rain terms of the cutting parameters of AJM. The models successfully edited the surface roughness of an AWJ machined glass/epoxy laminate within the hit of this study. Verification of the improvement in the quality characteristics has been made through confirmation test with respect to the chose reference parameter setting. It was confirmed that the determined optimum combination of AJM parameters satisfy the real need for machining of glass fibre reinforced epoxy composites in practice by M.A. Azmir, A.K. Ahsan

Micro abrasive jet machining (MAJM) is an economical and efficient technology for micro-machining of brittle material like glasses. The erosion of brittle materials by solid micro-particles is a complex process in which material is removed from the target surface by brittle fractures. The rate of material removal is one of the most important quantities for a machining process. Predictive mathematical models for the erosion rates in micro-hole drilling and micro-channel cutting on glasses with an abrasive air jet are developed. A dimensional analysis technique is used to formulate the models as functions of the particle impact parameters, target material properties and the major process parameters that are known to affect the erosion process of brittle materials. The predictive capability of the models is assessed and verified by an experimental investigation covering a range of the common process parameters such as air pressure, abrasive mass flow rate, stand-off distance and machining time (for hole machining) or traverse speed for channel Machining). It shows that model predictions are in good agreement with the experimental Results by J.M. Fana, C.Y. Wanga, J. Wang.

3. PROBLEM DEFINITION

In recent methods the glass hole making process are done manually by drilling machines. The operating cost of this process is high due to the use of advanced machines. So there is a need for reducing the operating cost. Also the machining time for making hole in this method about 10 second. As concern with this criteria, we are in developing of a new way for making hole and cutting of glass in economical view. The operating cost of this process is low as compared to older method and the machining time is also reduced to 4 seconds.

4. DESCRIPTION OF GLASS HOLING MACHINE

4.1 Main Components of the glass holing machine

1. Compressor
2. Nozzle
3. A C Motor
4. Abrasive and Sand Container

4.1.1 Compressor

Compressor is the air producing machine. They collect the airs from the atmosphere are in the running of machine are engine. Air compressors are utilized to raise the pressure a volume of air. Air compressors are available in many configurations and will operate over a very wide range of flow rates and pressures. Compressed air was expelled by primitive man to give glowing embers sufficient oxygen to allow them to flare up into a air. During the compression process, the temperature increases as the pressure increases. This is known as polytypic compression.. The amount of compression power also increases the temperature increases. Compressors are staged thereby reducing the temperature and improving the compression efficiency. The temperature of the air leaving each age is cooled prior to entering the next stage. This cooling process is called inter cooling. Volumetric efficiency also increases with multi-stage compression since the pressure ratio over the first stage will be decreased. Selections of the air compressor are only the first step in designing an efficient and disable compressed air system. The air exiting the compressor is saturated with moisture and will have compressor lubricants (lubricated compressors only). Other chemicals that have been drawn into the compressor intake may also be present. This contamination harmful to many processes, pneumatic tools, instruments and equipment.

4.1.2 Nozzle

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe an orifice. A nozzle is often a pipe or tube of varying cross sectional area and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control he rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them.

4.1.2.1 Specification

Diameter	: 3.5 mm
Pressure at the nozzle	: 1 bar
Stand of distance	: 2 mm

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Material : brass
Nozzle depth : 5 mm

4.1.2.2 Nozzle pressure calculation

Nozzle Discharge (GPM) = $30 \text{x} d^2 \text{x} \sqrt{NP}$
There NP = nozzle pressure
$= 30 \text{x} (3.5)^2 \text{ x } \sqrt{72.519}$
=3129.26 N/mm
Nozzle number = gpm x $\sqrt{4000/pr}$
=3129.26x $\sqrt{4000/72.519}$
= 23.02
Psi = 4000 x (gpm^2 / nozzle no^2)
= 4000 x (3129.26^2 / 23.02^2)
= 72.519 psi

4.1.3 A C MOTORS

An electric motor is an electromechanical device that converts electrical energy into mechanical energy. Most electric motors operate through the interaction of magnetic fields and current-carrying conductors to generate force. The reverse process, producing electrical energy from mechanical energy, is done generators such as an alternator or a dynamo some electric motors can also be used as generators, for example, a traction motor on a vehicle may perform both tasks. Electric motors and generators are commonly referred to as electric machines.

4.1.4 ABRASIVE AND SAND CONTAINER

An abrasive is a material, often a mineral that is used to shape or finish a work piece through rubbing which leads to part of the work piece being worn away. While finishing a material often means polishing it to gain a smooth, reflective surface it can also involve roughening as in satin, matte of beaded finishes. Abrasives are extremely commonplace and are used very extensively in a wide variety of industrial, domestic, and technological applications. This gives rise to a large variation in the physical and chemical composition of abrasives as well as the shape of the abrasive. Common uses for abrasives include grinding, polishing, buffing, honing, cutting, drilling, sharpening, lapping, and sanding (see abrasive machining). (for simplicity, "mineral" in this article will be used loosely to refer to both minerals and mineral-like substances whether man-made or not.). The materials used to make abrasives can be broadly classified as either natural or aesthetic. Natural abrasives include diamond, corundum, and emery; they occur in natural posits and can be mined and processed for use with little alteration. Synthetic abrasives, the other hand, are the product of considerable processing of raw materials or chemical cursors; they include silicon carbide, synthetic diamond, and alumina (a synthetic form of corundum). Most natural abrasives have been replaced by synthetic materials because nearly all industrial applications demand consistent properties. With the exception of natural diamond, most of nature's abrasives are too variable in their properties.

One of the most important properties necessary in an abrasive material in hardness. Simply put, the abrasive must be harder than the material it is to grind, polish, or remove. Hardness of the various abrasive materials can be measured on a number of scales, including the Mohs hardness test, the Knoop hardness test, and the Vickers hardness test. The Mohs scale, first described in 1812, measures resistance to indentation as judged by which material will scratch another. This scale, which assigns numbers to natural minerals, has been widely accepted and is used by mineralogists. The Knoop and Vickers hardness tests employ pyramid-shaped diamond indenting devices and measure the indentation made by the diamonds in a given test material. The Vickers test was designed primarily for metals. With the Knoop test, however, the hardness of extremely brittle materials including glass and even diamonds can be measured without harming either the indenter or the test piece. Toughness or body strength characteristics are also significant to abrasive function. Ideally, a single abrasive particle resharpens itself by the breakdown of its dull cutting or working edge, which exposes another cutting edge within the same particle. In synthetic abrasives it is possible to achieve some degree of control over this property by varying rain shape during the crushing or sizing operation, by making changes in the purity of the abrasive, by alloying abrasives and by controlling the

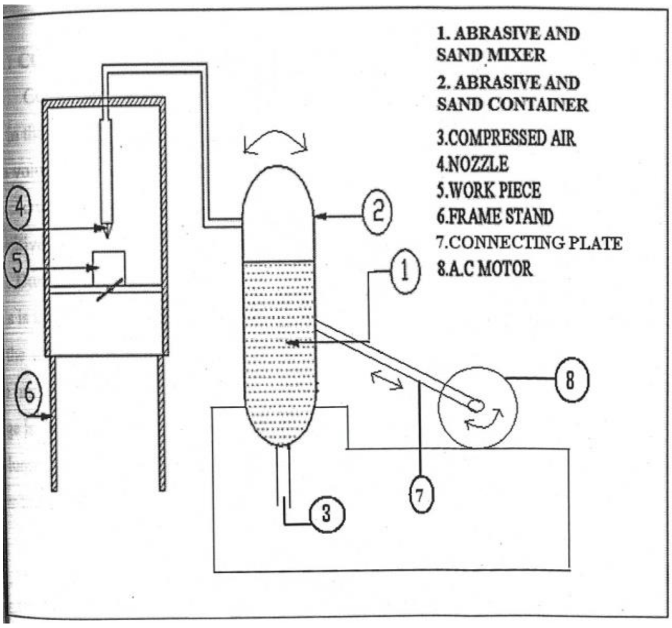

Fig 1 Glass Holing Machine

crystals structure within abrasive rains. Thus abrasives can be developed to meet the operating conditions found in a preity of applications. The glass holing machine is as shown in the figure 1.

5. FABRICATION PROCESS

The glass holing machine is mainly fabricated and developed by welding process. Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material. Gas Welding is a welding process utilizing heat of the flame from a welding torch.

The torch mixes a fuel gas with oxygen in the proper ratio and flow rate providing combustion process at a required temperature. The hot flame fuses the edges of the welded arts, which are joined together forming a weld after solidification. The flame temperature is determined by a type of the fuel gas and proportion of oxygen in the combustion mixture: 4500^0F – 6300^0F (2500^0C – 3500^0C). Depending on the proportion of the fuel gas and oxygen in the combustion mixture, the flame may be chemically neutral (stoichiometric content of the gases), oxidizing (excess of oxygen), and carburizing (excess of fuel gas).

Filler rod is used when an additional supply of metal to weld is required. Shielding flux may be used if protection of weld pool is necessary. Most of commercial metals may be welded by Gas Welding excluding reactive metals (titanium, zirconium) and refractory metals (tungsten, molybdenum).

6. WORKING

Glass holing machine removes material through the action of a focused stream of abrasive-laden gas. Micro-abrasive particle are propelled by inert gas at velocities of up to 300 m/sec. when directed at a work pieces, the result in erosion can be used for cutting, etching, cleaning, deburring, polishing, and arilling.

Material removal occurs through a chipping action, which is especially effective on hard, brittle materials such as glass, silicon, tungsten, and ceramics. Soft, resilient materials, such as rubber and some plastics resist the chipping action and thus are not effectively processed by glass holing machine.

No work piece chatter or vibration occurs with this process because the large mables GHM to produce fine, intricate detail extremely brittle objects. The GHM processed eggshell provides a graphic example of the delicate nature of the process. In addition because heat carried away by the abrasive propellant gas, work pieces experience to thermal damage.

6.1 Specification of Glass holing machine

Pressure used	: upto 5 bar
Pass Thickness	: upto 4 mm
Abrasive material composition	: sand (40%) + abrasive power (10%) + air (50%)
Required to holing a glass	: 2 sec

6.2 Working of Glass cutting machine

The glass cutting machine contains of double acting cylinder, at the end piston rod has diamond tip connected. During the forward stroke of the piston the glass material is cut.

7. RESULTS AND DISCUSSION

- Variety of diverse jobs has been successfully performed by Glass cutting and holing machine.
- This process includes cutting threads into glass rods, deflashing small castings, die and mound touch up, cutting titanium fink and drilling glass wafers.
- The glass cutting and holing machine has been successfully employed to manufacture small electronic devices consisting of a 0.38 tungsten disk. After the two materials were brazed together. The silicon wafer must be trimmed and beveled without harming the tungsten disk. To accomplish the task a GHM nozzle is mounted at the desired angle and directed at slowly rotating part with this technique the unwanted silicon is trimmed off each part in less than one minute.
- An example of debarring plastic parts with GHM is cited by Lamoure (1979) in an application involving the manufacture of small biomedical analysis packages. Small plastic cubes are cross drilled with two 0.34mm diameter holes. Tiny burrs are created internally at the intersection of the two holes must be removed without providing scratches. It is not only able to meet this difficult quality requirement, but it also was able to reduce debarring time by 80% when compared with the old method of debarring.

8. CONCULSION

- As the problem defined in our project, the glass hole making process is done manually and using of hi-tech machines in which the operating cost is more.
- GHM provides cool holing action, no heat damage occurs to the delicate work materials.
- Glass holing and cutting action is shock less.
- Ability to cut fragile and heat sensitive materials without damage.
- Ability to cut intricate hole shapes in materials of any hardness and brittleness.
- No variation due to surface irregularities and tool wear as in conventional machining.
- Hence the fabrication of pneumatic operated glass holing machine results in better advantage in economic aspects and also mainly in operators safety.

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