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REVIEW PAPER

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ABSTRACT:- AJM has become a very useful method for micro machining. It has enormous number of distinct advantages over the other non-traditional cutting and drilling methods, that include high machining versatility and minimum stresses on the substrate. This abrasive jet machining project is used for drilling holes on brittle materials like glass. Holes can be created in brittle material and glass with the usage compressed air and abrasive particles. A compressor used is connected through high pressure pipe to the control valve. Control valve controls the air through pipes to the nozzle. A pressure gauge is attached to measure the pressure through the pipes. Pressure relief valve is also used which is attached between control valve and nozzle which performs the cleaning of air that passes to the mixing chamber. Mixing chamber is used mix clean air with the abrasive particle at a high pressure. The abrasive particle can be introduced from the upper inlet of the mixing chamber. A nozzle is connected to the end of the mixing chamber where discharge takes place. Nozzle has the function of increasing the velocity of high pressurized discharged air that is mixed with the abrasive particle. This discharged air is impacted on the material which is held by the vice. Thus, the desired hole is obtained.

INTRODUCTION :- Abrasive jet machining (AJM) is one of the advanced machining processes (mechanical energy based) in which a high velocity jet of abrasives is used to remove material from the work surface by impact that leads to the erosion of material from the workpiece. The abrasive jet is obtained by accelerating fine abrasive particles in highly pressurized gas which is also known as carrier gas. A nozzle is used whose function is to convert the pressure energy into kinetic energy and also has the role of directing the jet towards the work surface at a particular angle known as impingement angle. Upon impact, hard abrasive particles gradually remove material by the erosion process and sometimes assisted by brittle fracture. AJM differs from age-old sand blasting technique by a notable level in terms of accuracy and precision. AJM utilizes various abrasives including alumina, silicon carbide, glass beads, sodium bicarbonate, etc.; whereas sand blasting predominantly utilizes only silica sand (SiO2). Although the purposes of both the processes are quite similar, cutting parameters can be controlled in AJM and thus it can provide better accuracy and precision.

An abrasive machine was fabricated in the institute workshop with required raw materials and procured components. Before that a detailed design of the functional subsystems were made using computer aided design tools. For this CATIA software was used which is very good in product design and analysis. The components that were designed include the machining chamber, work-holding device, nozzle and its holder, abrasive container and vibrating unit, cam and total piping system. Care was taken to optimally use the material and space in the production engineering lab along with ease in using. The final components were fabricated in the workshop using the available materials like mild steel sheets, bars and pipes, Aluminum sheets, rubber sheets, glass fiber, standard nuts and bolts etc. For fabrication purposes the welding machine, grinding machine, the hand-drill, sheet-bending machine, and shearing machines were used. Some components are procured from the commercial market to improve accuracy.

The abrasive particles used in AJM are of very fine grit size and can remain suspended in the air for a very long time. Normally it is injurious to health if inhaled. So proper care has to be taken to prevent it from mixing with the atmosphere and dispose of it. For this purpose the chamber was made airtight by application of suitable methodology.

In the AJM machining process the most common work pieces are glass sheets, glass fiber sheets, ceramic slabs etc. due to their brittleness. Material removal rate is lesser in ductile material due to the fact that ductile materials try to get embedded in the work material. For securing the work piece in its place L shaped angle plates was used with holes drilled on them long their length.

For opening and closing of the chamber hinge joint was provided for simplicity. The front panel of glass fiber can be opened by this method. The hinges were of mild steel material and light weight in nature.

The abrasive particles carried in high pressure air stream should be disposed of safely otherwise they will get accumulated and hence create problems further. For safe drainage of particles a two way sloped passageway was provided.

LITERATURE REVIEW

1. This study concerns the determination of the significant factors for an innovative deburring process: low pressure abrasive water-jet blasting. The abrasive medium aluminium oxide

(Al2O3) is classified according to the individual characteristics of different grain sizes. Then, the particle behaviour in the air jet is analysed with an optical measuring method, Particle Image Velocimetry (PIV); the velocity profile and the particle distribution of the dispersed system are obtained. In addition to the CAE based development process, a design of experiments for the system characterization should be carried out. Now, the outlook is to develop a novel deburring process, namely low-pressure abrasive water-jet blasting, by obtaining explicit values of major variables, determining dependencies of variables and building a novel simulation model.

2. The accuracy of the abrasive water jet is sufficient for osteotomy, but the jet parameters have to be optimized for the implantation of endoprostheses. If the parameters have been optimized with respect to the cutting quality the abrasive water jet may be the cutting technique of the future for robotic usage. The quality of bone cuts is assessed by the accuracy and biological potency of the cut surfaces. Conventional tools (such as saws and milling machines) can cause thermal damage to bone tissue.
3. Banyan tree saw dust powder (BSD) filled Polypropylene (PP) green composites have been fabricated with varying amounts viz., 0%, 20%, and 40% of BSD particulate filler by using a co- rotating twin screw extruder followed by injection molding. The impact strength of the PP/BSD composites also decreases considerably with increase in filler loading. Incorporation of 4 wt% coupling agent (PP-g-MA) helps to improve the tensile strength but impact strength and elongation at break do not improve significantly.
4. The carried out comparative analysis expresses how important can be the functions of the roughness parameter and other geometric elements of the topography of generated surfaces. For both types of tools, the surface roughness acts here completely newly as a common denominator of mechanism of work. the question of technologies using rigid tools that are just being tackled are specified on the qualitative and the quantitative level and in the form of graphical dependencies.
5. This investigation has been elaborated in the framework of the project Institute of Clean Technologies for Mining and Utilization of Raw Materials for Energy Use, Reg. No. CZ.1.05/2.1.00/03.0082, IT4Innovations Centre of Excellence project, reg. no. CZ.1.05/1.1.00/02.0070 supported by Operational Programme Research and Development for Innovations funded by Structural Funds of the European Union and state budget of the Czech Republic and the project RMTVC No. LO1203.
6. The objective of this research work is to machine holes on the glass fiber reinforced polymer composite using an abrasive jet machine under various levels of process

parameters. The material removal rate and hole geometry (kerf analysis) were observed as a part of the investigation. Four factors five levels central composite rotatable design matrix was used for optimizing the required number of experiments.

7. ultra-high-pressured water (up to 10 kbar) is forced through a sapphire nozzle issuing a high-speed water jet into the mixing-and-acceleration head. The solid particles are dragged into the mixing chamber through a separate lateral inlet due to the suction created by the water jet. The mixing of particles and water, involving jet break-up and air entrainment, is congruent with momentum transfer between the phases followed by further acceleration of the abrasives in a focusing tube.
8. PJM is capable of drawing deep aspheric or free-form substrates with high material removal rate and high spatial resolution. Based on chemical reactions between plasma generated radicals and the surface, PJM does not introduce any damage to the processed surface and sub- surface region in contrast to abrasive techniques.
9. Based on this concept the technology is also tested for further materials at this time. Apart from the dewatering of moist fossil fuels, the process is especially suitable for the dewatering of suspensions containing ultrafine particles (d < 10 mm) which are difficult to dewater nowadays.
10. fracture toughness, flexural strength and relative density continuously increase with increasing (W,Ti)C content up to 50 wt-% for B4C/(W,Ti)C composite, while hardness decreases with increasing (W,Ti)C content. The sintering temperature was lowered from 2150uC for monolithic B4C to 1850uC for B4C/(W,Ti)C composite. The hardness of B4C/(W,Ti)C ceramic nozzles had an important influence on erosion rate in sand blasting.
11. The machining performance of AWJM process naturally depends on its several control (input) parameters, like water pressure, nozzle diameter, jet velocity, abrasive concentration, nozzle tip distance etc., which have also predominant effects on its responses, i.e., material removal rate, surface roughness, overcut, taper etc.
12. Abrasive jet machining (AJM) is an unconventional and novel machining process whereby micro abrasive particles are propelled at high velocities onto a workpiece. The resulting erosion can be used for cutting, etching, cleaning, deburring, drilling and polishing.
13. According to the percentages of ANOVA, it was found that nozzle feed rate was 48.7 %, abrasive flow rate was 27.1 % and ND 9.7 %, respectively, on average surface roughness. When the abrasive flow rate was increased from 50 gmin 1 to 350 gmin 1, the average

surface roughness decreased by 81 %. The average surface roughness value increased by 22 % when the distance between the workpiece and nozzle was increased from 2 mm to 11 mm, Figure 10. When the nozzle feed rate was increased from 10 mm to 25 mm, the average surface roughness value increased by 16 %. When the turning speed was increased from 25 mm min? 1 to 100 mm in? 1, the average surface roughness value improved by 55 %.

14. Conventional grinding ofthe ceramic resulted in a surface that was dominated by intergranular fracture, whereas, during AJM, impact by the abrasives led to material removal in a manner resembling ductile behavior, and the resulting surface appearance was much smoother.
15. It is found that surface roughness is reduced by 3% as compared to experimental values. However, observed values of surface roughness are reduced by around 11–32% as compared to previous research work.The results of the present study are useful to produce good- quality parts of carbon epoxy composite by AWJM process.
16. It was noted that the value of machined surface roughness Ra was reduced by 4–10% when hot air is used as carrier media. It is further observed that the value of surface roughness is very less at 310_C for grain size of 100 mm andis highest at 27_C and for grain size of 150 mm.

ADVANTAGE AND DISADVANTAGE OF ABRASIVE JET MACHINE

ADVANTAGE

1. The process is free from chatter and vibration as there is no contact between the tool (nozzle) and work material.
2. Do not cause hardening of workpiece material.
3. Very little or no heat generation during the cutting process, so it is suited for machining of heat sensitive material.
4. High surface finish can be obtained by choosing a suitable abrasive material with a size that is suitable for the requirement.
5. In case of damage, the depth of damage is very small (less than 3 microns).
6. Thin sections of brittle and hard material like ceramic, glass, and germanium can be machined.
7. It can be used for drill holes of intricate shape. It is used for machining cavities which are inaccessible by other methods.
8. Low capital cost and ease of operation.

DISADVANTAGE

1. The material removal rate is low.
2. The process tends to environmental pollution. A dust collection system must be provided to avoid air pollution and health hazards. This can be eliminated by using abrasive water jet machining.
3. The abrasive powder cannot be reused because its cutting ability decrease and it may clog on orifice of the nozzle.
4. Higher chance of stray cutting. Tapering may occur during drilling.
5. AJM not suited for machining of soft material because the abrasive may get embedded in the work material.
6. Nozzle life is low (300hr), and short standoff distance causes frequent damages on the nozzle.
7. The air used for abrasive jet must be moister and oil free.

CONCLUSIN AND FUTURE SCOPE

Conclusion: A detailed study of the AJM has been undertaken that included an experimental investigation, ANN modelling and optimisation of the process parameters governing MRR.

The following are specific conclusions:

- The investigation has demonstrated that MRR increased with increase in the kinetic energy of the abrasive particles.
- It was found that applied pressure was the most significant parameter influencing MRR.
- Nozzle diameter has a considerable effect on MRR. For nozzles too small or too large in diameter relative to particle size, the MRR decreased.
- The MRR increased with the increase in standoff distance up to a certain limit and then the MRR decreased with the further increase of standoff distance.
- MRR increased with increase in abrasive grain size.
- Highest values of MMR occurred at an impact angle of 90º, oblique impact gave a lower MRR.

- An ANN was developed to model an AJM process with small error and, once trained, could predict the MMR for any set of process parameters. It was found that $4 \times 7 \times 7 \times 1$ was the best network structure for estimating the MRR with a maximum error of 5.3%.
- The result showed that the GA is a fruitful technique to identify the optimum solutions for maximum MRR with an error of 8.4%.
- To obtain maximum MRR depends on a suitable simultaneous selection of each and every parameter; e.g. applied air pressure must be suited to the standoff distance and particle grain size must be suited to nozzle diameter.
- It is recommended to apply different optimization techniques such as the Bees Algorithm and Fuzzy logic to evaluate their performance and determine the most appropriate method for this application.

Future Scope: In future, the efficiency of the Abrasive jet machine systems can be improved by incorporating newer materials and parts. First of all, we should have a clear cut idea of our systems, and then depending on the type of work material used, we should select the design parameters. Use of masks or stencils to control overspray or to produce holes of larger diameter and a high degree of detail without moving the nozzle and tracing the shape is also possible. In selecting nozzle material, to withstand the abrasion at the exit of the nozzle, the chosen material has to be one with hardness values significantly higher than the abrasive mix being used. In most of the precision works, brass has played a vital role in the nozzle. So using a more rigid material such as tungsten carbide may give higher stability of cut without stray cut and taper hole. For shaking the mixing chamber, a manual handle is used. This can be done automatically by using a motor. Using a dust collecting system and air filter, the environmental loading and hazards can be eliminated for eco-friendly machining. Beyond several traditional applications, some futuristic applications of the abrasive jet are,

1. Cutting tools blasting after grinding.
2. Abrasive jet etching.
3. Surface cleaning before welding.
4. Cryogenic abrasive jet for machining polymers.

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