EasyChair Preprint

№ 7521

Surface Finishing OnAbrasive Jet Machining

Aakash Garg and Rajendra Kumar

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

March 5, 2022

REVIEW PAPER

Surface Finishing OnAbrasive Jet Machining

1Student, 2Assistant Professor
Aakash Garg, Mr. Rajendra Kumar Gupta
Department of Mechanical Engineering Jaipur Engineering College &Research Centre Jaipur, Rajasthan

ABSTRACT:-With the development of technology, more and more challenging problems are faced by the scientists and technologists in the field of manufacturing.The many new materials and alloys that have been developed for specific uses possess a very low machinability. Producing complicated geometries in such materials becomes extremely difficult with the usual methods. To tackle such difficult jobs two approaches are possible, viz., (i) a modification of the traditional processes and (ii) the development of new processes. This presents the modelling of an Abrasive Jet Machine. The individual parts are fabricated and assembled in theworkshop.

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 byimpactthatleadstotheerosionofmaterialfromtheworkpiece.Theabrasivejetisobtainedby acceleratingfineabrasiveparticlesinhighlypressurizedgaswhichisalsoknownascarriergas.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 notablelevelintermsofaccuracyandprecision.AJMutilizesvariousabrasivesincludingalumina, siliconcarbide,glassbeads,sodiumbicarbonate,etc.;whereassandblastingpredominantlyutilizes only silica sand (SiO_2). Although the purposes of both the processes are quite similar, cutting parameters can be controlled in AJM and thus it can provide better accuracy andprecision.

Abrasive: An abrasive is a material, often a mineral, that is used to shape or finish a workpiece through rubbing which leads to part of the workpiece being worn away by **friction.** Whilefinishingamaterialoftenmeanspolishingittogainasmooth,reflectivesurface,theprocess can also involve roughening as in satin, matte or beaded finishes. In short, the ceramics whichare usedtocut,grindandpolishothersoftermaterialsareknownasabrasives.Abrasivesareextremely 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. Some common uses for abrasives includegrinding, polishing, buffing, honing, cutting, drilling, sharpening, lapping, andsanding (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 ornot.)

Abrasive is a tool used for shaping or giving a fine finish to the workpiece by rubbing. By doing this,thefrictionwearsawaysomepartoftheworkpiece.Itcanalsodothedetailingofaworkpiece,i.e. polishing to get a silky, smooth and shiny surface. Users can obtain various types of finishes like satin, matte or beaded finishes. In short, the abrasive is a form of ceramic used for cutting, grinding and polishing other softer materials. It is commonly used in industrial, domestic and technological applications. Along with cutting and grinding, users can perform buffing, honing, drilling, sharpening, lapping and sanding using these abrasives.

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
2. This study investigates whether the abrasive jet cutting quality in cancellous bone with a biocompatible abrasive is sufficient for the implantation of endoprostheses or for osteotomies. Sixty porcine femoral condyles were cut with an abrasive water jet and with an oscillating saw.
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 corotating twin screw extruder followed by injection molding. The mechanical properties such as surface hardness, tensile behavior, and impact strength of the fabricated PP/BSD green composites have been studied in order to standardize the composites

4. The roughness of cut surfaces is used here as an important characteristic for both the types of tools. It enters as a necessary variable into newly derived equations enabling the theoretical calculation of parameters of a flexible cut and chip.
5. 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.
6. High cutting speed combined with close tolerances, multidirectional machining capability, and high versatility are only a few advantages of this process. Most highly valued are the minimal heat build-up and low deformation stresses within the machined part. The basic principle of AWJ machining is the erosion of the workpiece by solid particles suspended in a high-speed water jet.
7. It is under development for the surface figuring of a variety of optical materials by IOM for about 15 years. PJM is capable of drawing deep aspheric or free-form substrates with high material removal rate and high spatial resolution
8. 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.
9. show that fracture toughness, flexural strength and relative density continuously increase with increasing (W,Ti)C content up to 50 wt-% for B_4C/(W,Ti)C composite, while hardness decreases with increasing (W,Ti)C content. The sintering temperature was lowered from 2150uC for monolithic B_4C to 1850uC for B_4C/(W,Ti)C composite. The hardness of B_4C/(W,Ti)C ceramic nozzles had an important influence on erosion rate in sand blasting.
10. The main advantage of this algorithm is that it does not accumulate towards some local optima, and the presence of a social hierarchy helps it in storing the best possible solutions obtained so far. The derived results using GWO exhibit a significant improvement in the response values as compared to the previous attempts for parametric optimization of AWJM processes while applying other algorithms.
11. The resulting erosion can be used for cutting, etching, cleaning, deburring, drilling and polishing. In the study completed by the authors, statistical design of experiments was successfully employed to predict the rate of material removal by AJM. This paper discusses the details of such an approach and the findings

12. The effects of the abrasive water jet turning processing parameters on the average surface roughness and the macro and micro surface characteristics were analyzed. The analysis of variance (ANOVA) was performed by using the interaction between the factors affecting the average surface roughness and macro and micro surface characteristics and linear regression model was presented

13. The effect of AJM on the material removal behavior of a commercially available alumina ceramic, and its effect on mechanical properties, was characterized and compared with identical material subjected to conventional finishing processes.

14. An analytical model has been developed based on the above observations for predicting the material removal in an abrasive jet machining process. The model also suggests the critical value of mass flow rate which has been substantiated experimentally.

15. Accuracy Of machined components is very important in every industry and geometrical accuracy of holes is vital in case of subassemblies of components. In this perspective, the researchers/experts updated their machinery from time to time.

Characteristics of Abrasive Jet Cutting (AJM)

1. Abrasive — Al_2O_3 or SiC to be used once
2. Size of abrasive — around 25 µm
3. Flow rate — 2—20 g/min.
4. Medium — Air or CO_2.
5. Velocity — 150—300 m/sec.
6. Pressure — 2 to 8 kg/cm^2.
7. Nozzle — WC or sapphire with orifice area—0.05 to 0.2 mm^2
8. Life of nozzle — WC (12—30 hrs), sapphire (around 300 hrs)
9. Nozzle tip distance — 0.25 to 15 mm
10. Tolerance — ± 0.05 mm
11. Surface Roughness — 0.15—0.2 µm with particles of 10 µm size, 0.4—0.8 µm and 1.0 to 1.5 µm, with particle size of 25 and 50 µm.
12. Work material – Hard and brittle materials like glass, ceramic, mica, etc.
13. Machining operations – Drilling, cutting, deburring, cleaning

14. Advantages – Can cut intricate hole shapes in hard and brittle materials, fragile and heat sensitive materials can be cut without damage because there is no heating of working surface
15. Limitations – Low material removal rate, low accuracy (0.1 mm) due to stray cutting (taper effect), and abrasives get embedded in surface if material is soft.

FUTURE SCOPE OF ABRASIVE JET MACHINING

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 ofoursystems,andthendependingonthetypeofworkmaterialused,weshouldselectthedesign 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 canbe eliminated for eco-friendly machining. Beyond several traditional applications, some futuristic applications of the abrasive jetare

1. Cutting tools blasting aftergrinding.
2. Abrasive jetetching.
3. Surface cleaning beforewelding.
4. Cryogenic abrasive jet for machining polymers.

REFERENCES

[1] Wanting Wang, Dirk Biermann, Robert Aßmuth, A.F.M. Arif and S.C. Veldhuisa (2020), “Effects On Tool Performance Of Cutting Edge Prepared By Pressurized Air Wet Abrasive Jet Machining (PAWAJM)”.

[2] Arunesh Patel, Chintan Chudgar, Hrishikesh Marathe, ShreyMacwan and Nirajkumar Mehta (2020),” ModelingAnd Fabrication Of Abrasive Jet Machine”.

[3] D. Maneiah, M. Shunmugasundaram, A. Raji Reddy and Zareena Begum (2020), “Optimization Of Machining Parameters For Surface Roughness During Abrasive Water Jet Machining Of Aluminium/Magnesium Hybrid Metal Matrix Composites”.

[4] C. Joel, Linda Joel, S. Muthukumaranand P. Matilda Shanthini (2020), “Parametric Optimization Of Abrasive Water Jet Machining Of C360 Brass Using MOTLBO”.

[5] Ehsan Azarsa, Amro Ibrahim and Marcello Papini (2020), “Abrasive Water And Slurry Jet Micro-machining Techniques For Fabrication Of Molds Containing Raised Free-standing Micro Features”.

[6] Dipak Kumar Jesthi and Ramesh Kumar Nayak (2020), “Sensitivity Analysis Of Abrasive Air Jet Machining Parameters On Machinability Of Carbon And Glass Fiber Reinforced Hybrid Composites”.

[7]R. Selvam, N. Arunkumar and L. Karunamoorthy (2020), “An Investigation On Machining Characteristics In Abrasive Water Jet Machining Of Hybrid Laminated Composites With Sic Nanoparticles”.

[8] Anu Tomy and Somashekhar S. Hiremath (2020), “Machining And Characterization Of Multidirectional Hybrid Silica Glass Fiber Reinforced Composite Laminates Using Abrasive Jet Machining”.

[9] Xiangyu Luo, Joshua Palumbo, Marcello Papini and Jan K. Spelt (2019), “Aerodynamic Focusing Of An Abrasive Air Jet And Its Effect On Machining Resolution”.

[10] P.S. Vishnu, P.V. Pradeep and Lijo Paul (2019), “Experiment On Pollution Control In Abrasive Jet Machining Using Liquid Films”.

[11] Ketan Verma, Anandakrishnan V. and Sathish S. (2019), “Modelling And Analysis Of Abrasive Water Jet Machining Of Aa2014 Alloy With Al2o3 Abrasive Using FuzzyLogic”.

[12] Pranav P Kulkarni, Dhiraj Suryawanshi and Prashant Patil (20219), “Study Of Abrasive Jet Machines”.

[13] Dr. R. Rajavel, M. Surajkumar, Mrs. K. Srividhya, S. Vignesh and S. Logeswar (2019), “Design, Fabrication And Analysis Of An Abrasive Jet Machine Using Alternate Abrasive Particles”.

[14] Aditya S. Bhumre, Ravina R. Gaikwad, Akash V. Shinde, Amruta V. Thombare Abhimanyu K. Chandgude and Shital P. Kharat (2019), “Optimization Of Abrasive Water Jet Machine Parameters: A Review”.

[15] Sanjay C. Shah, Dipesh P. Patel and Bhupendra N Parmar (2019), “Parametric Analysis Of Abrasive Water Jet Machining”.

[16] KetulkumarRajubhai Patel, Pallavi H. Agarwal, andDravya A. Patel (2019), “Effect OfInput Parameters OnGfrp With Sic As Abrasive Using Abrasive Jet Machining: An Experimental Investigation”.

[17] C.Joel and T.Jeyapoovan (2019), “Machinability Optimization Of Abrasive WaterJet Cutting Process On Aa6082 Aluminium Alloy”.

[18] İsmail Tekaüt (2019), “Theoretical Evaluation Of The Effect Of Surfaces Processed With Abrasive Water Jet On Fatigue Life”.

[19] S.Ramanathan, E.Naveen, K.Vijay, M.J.Campbell Terrain and S.AnishKisshore (2019), “Flow Simulation In Abrasive Fluid Jet Machining With Water As Carrier Medium UsingCfd”.

[20] Kumar Abhishek, Somashekhar S. Hiremath and S. Karunanidhi (2018), “A Novel Approach To Produce Holes With High Degree Of Cylindricity Through Micro-abrasive Jet Machining (mAJM)”.