A Review on Optimization of Abrasive Water Jet Machine Process Parameters usingResponse Surface Method on Borosilicate Glass

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Abstract

Borosilicate glass is one of the most regularly used amorphous engineering materials.Brittleness of this glass puts limitation on its machining by conventional machining processes.The objective of experimental investigation is to conduct research of machining parametersimpact on MRR and Surface roughness of Borosilicate Glass. In this Study, Response SurfaceMethod is used to find optimum parameters for abrasive water jet machining (AWJM). Theprocess parameters selected for this experiment are water pressure, abrasive flow rate and jettraverse speed. Box Behnken Design will be used for the Design of Experiment. ANOVA andRegression Analysis Will be carried out for Verification of Model. The determined optimumcombination of AWJM process parameters satisfy the real need for machining of BorosilicateGlass in actual practice.

I. INTRODUCTION

Materials commonly cut with a water jet include textiles, rubber, foam, plastics, leather, composites, stone, tile, glass, metals, food, paper and much more. "Most ceramics can also be cut on an abrasive water jet as long as the material is softer than the abrasive being used (between 7.5 and 8.5 on the Mohs scale)". Examples of materials that cannot be cut with a water jet are tempered glass and diamonds.Water is capable of cutting materials over 18 in (460 mm) thick.

IILITERATURE REVIEW

Probal Kumar Das, Simul Banerjee, “Abrasive Water Jet Cutting of Borosilicate Glass”, Procedia Materials Science 6 (2014) 775 – 785, 3rd International Conference on Materials Processing and Characterisation (ICMPC 2014).[1]In this article, experiments are conducted on cutting of borosilicate glass by AWJM. Depth of cut is measured with different machine parameter settings – water pressure, abrasive flow rate, traverse speed and standoff distance. Model, thus developed, on depth of cut gives an idea of the influence of different parameters on cutting of amorphous borosilicate glass by AWJM. Optimum condition of control parameter setting is also searched through particle swarm optimization (PSO). In addition, scanning electron microscopic image reveals to some extent, the nature of cut surface and erosion behaviour of amorphous material qualitatively.

L27 orthogonal array is chosen as the experimental design and corresponding 27 experiments are conducted according to the orthogonal array settings. The depth of cut is measured at the jet entrance surface (shown in figure 1) of the sample by Vernier Calliper with accuracy 0.02 mm. The values of response, thus obtained, are then considered for model building and optimization.

In this study, one of the purposes of choosing borosilicate glass as workpiece material is to understand the erosion behaviour ofabrasive water jet inside amorphous material. Here, the sample cut with optimum control parameter setting (water pressure = 1500 bar, abrasive flow rate = 54 g/min, traverse speed = 200 mm/min standoff distance = 60 mm) obtained in the process of maximizing depth of cut, is considered for scanning electron microscopic (SEM) study of cut surface.

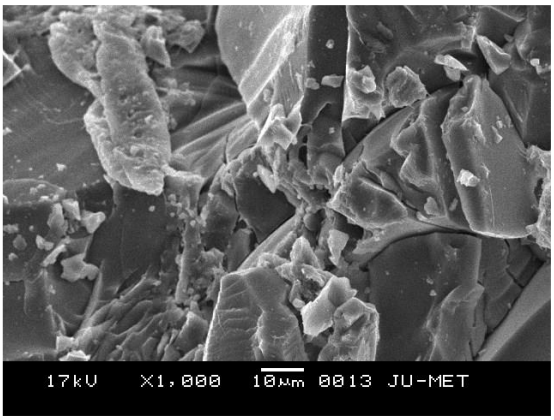

Figure 2.1 SEM photographs (a) fragmentation of surface.

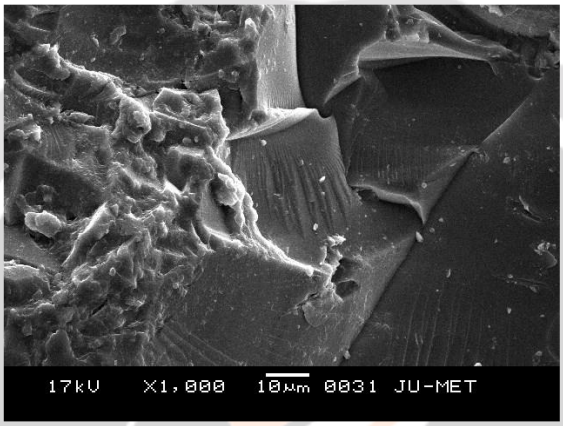

Figure 2.2 SEM photographs (b) gradual step formation.

UshastaAich, "Study on Cutting Characteristics of Abrasive Water Jet Machining On Borosilicate Glass", G.C. Sen Memorial Machine Tools Research Laboratory, Mechanical Engineering Department, Faculty of Engineering and Technology, Jadavpur University, Kolkata, May 2013 [2] has Researched about influence of different control parameters variation on material removal rate and depth of cut. Mechanism of material removal was also a part of investigation for better understanding of the process.

The proposed optimization techniques MOSA and MOOPSO applied on models developed by regression analysis give almost same result within the specified search range and the result is validated through follow up experiment. It is found that highest level of water pressure, abrasive flow rate and standoff distance with lowest value of traverse speed within the specified search range (water pressure = 1500 bar, abrasive flow rate = 54 g/min, traverse speed = 200 mm/min and standoff distance = 60 mm) simultaneously maximize material removal rate and depth of cut. Though the results are same, yet, it is suggested to apply MOPSO rather than MOSA due to its less time and low memory space requirement. Proposed MOPSO is further applied on simultaneous model of MRR and DOC developed by SVM and the result obtained is found almost same as that obtained from regression models before.

Scanning electron microscopic study of cut surface provides an idea about the material removal mechanism of amorphous material. Both the ductile and brittle nature of amorphous material borosilicate glass is appeared from this study. Surface fragmentation at the top portion and material flow in the lower section are proposed as the possible erosion mechanism in AWJ cutting of amorphous material

P. P. Badgujar, M.G.Rathi, "Abrasive Water Jet Machining - A State of Art", IOSR-JMCE, e-ISSN: 2278-1684, p-ISSN: 2320-334X., Volume 11, Issue 3 Ver. VI (May- Jun. 2014), PP 59-64.[3] Has described the basic features of AWJM, such as, its mechanism of material removal, advantages, disadvantages and application possibilities.A variety of materials can be cut by AWJM process. AWJM is a safer and more effective tool for quality cutting. This paper is use to comparative study of AWJM with other traditional and non-traditionalmachining processes. In this paper application, advantages and disadvantage of AWJM are listed.

B. Satyanarayana, G. Srikar, "Optimization of Abrasive Water Jet Machining Process Parameters Using Taguchi Grey Relational Analysis (TGRA)", International Journal of Mechanical and Production Engineering, ISSN: 2320-2092, Volume- 2, Issue-9, Sept.-2014.[4] The following conclusions can be drawn from this Research Paper: The optimal parameter values are abrasive flow rate at 20.41 gm/sec, pressure at 344.7Mpa and Stand-off distance at 3mm. At these parameters the values of MRR and kerf width are 1053.2 mm^3/min and 1.54mm respectively. It is shown that the

performance characteristics of the AWJM process, namely water jet pressure, abrasive flow rate and standoff distance are improved together by using Taguchi Grey Relational Analysis.

From ANOVA it is found that water jet pressure has more significant effect on kerf width and MRR rather than abrasive flow rate and standoff distance. The predicted S/N ratio is nearest to the conformation test S/N ratio; this explains that the TGRA process adopted for optimization of parameters is accurate.

Preeti, Dr. Rajesh Khanna, Rahul Dev Gupta, Vishal Gupta, "Measuring Material Removal Rate of Marble by Using Abrasive Water Jet Machining", IOSR-JMCE, e-ISSN: 2278-1684, p-ISSN: 2320-334X., PP 45-49.[5] has given details of measuring the material removal rate of marble by abrasive water jet machining in this Paper. The effect of the three process parameters, i.e., water pressure, abrasive flow rate and standoff distance on material removal rate is investigated. In this investigation, we are using L16 orthogonal array and the analysis of variance that was helped to find the highly significant, significant and non-significant parameters. Material removal rate increased when water pressure and abrasive flow rate increased.

From Figure 2.3, it is observed that when increase water pressure from level 1 to level 4, MRR also increases. When water pressure is 151.68MPa, MRR is minimum and at level 4 water pressure is 317.16MPa, MRR is maximum. When increase in abrasive flow rate from level 1 to 4, results MRR increases. In this case, higher abrasive flow rate is desirable to produce a higher the MRR. The influence of SOD is not significant as that of other process parameters.

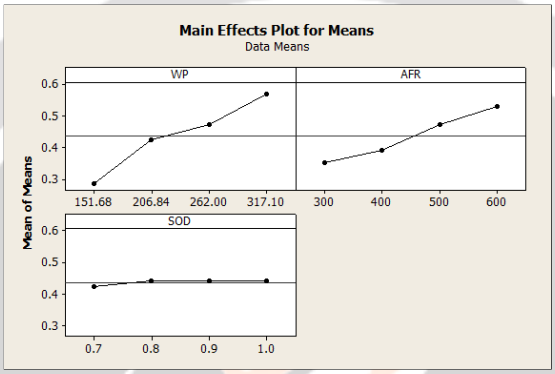

Figure 2.3 Effect of control factors on MRR.

III CONCLUSION

From this literature Review I have concluded that, very less work has been done in AWJM Cutting of Borosilicate Glass. Also verymuch Research is needed in this Field. Thus from this literatures Process Parameters and Responses are Selected.

ACKNOLEDGMENT

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