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# Non Traditional Machining: A Review

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## Abstract

The selection of optimum method setting is crucial for non non traditional machining processes, as these processes sustain a high initial investment, tooling value, and in operation and maintenance prices. During this paper, a review of machining method parameters setting for various materials is completed in unbearable machining (USM). Machining of various materials like ceramics, Glass ceramic ware, Titanium, is completed by totally different researchers victimization unbearable machining some materials like super alloys still want an exploration thanks to their wide applications in numerous industries. Numerous machining parameters like Static loading, kinds of abrasive, suspension concentration, tool pure mathematics are studied by researchers. This is often discovered from the varied analysis works that the on top of aforementioned parameters plays a significant role in achieving optimum price of MRR and Surface end in unbearable machining.

**Keywords:** Non Tradition, USM, Power

## Introduction

The machining of super alloys, ceramics, glass etc. to their final form by non traditional methods is very robust, time intense, and usually not possible. Advanced machining processes have emerged to hit these difficulties. Tight tolerance and dimension with suitable surface are sometime only attainable at huge value. There are few machining strategies existing that ensure high efficiency and accuracy, but explicit machining methods to accomplish these are needed to attain this. The ultrasonic machining is one in all the feasible processes for the precision machining of those kinds of material because of its unique characteristics. as a result of high investment and in operation prices, there's an financial need to operate the ultrasonic machine as efficiently as possible in order to obtain the invested with pay back. The success strictly depends on the selection of machining method parameters. correct alternative of method parameters plays a big position in ensuring the product quality, reducing the machining value, rising productivity.

Ultrasonic machining could be a non-traditional machining method within which abrasives contained in slurry are driven against the surface by a tool oscillating normal to the work surface at low amplitude (25-100 microns) and high frequency (15-30 kHz). it is preferably used to machine arduous and brittle materials having hardness greater than 40 HRC with smart accuracy and reasonable surface finish. usually the tool is pressed downward with a feed force, F between the tool and work piece. The machining zone is flooded with hard abrasive particles inside the water based slurry. The abrasive particles, as they indent on the work material, the material get removed if the work material is ideally brittle. Figure one shows the basic parts of an USM setup. throughout indentation, as a result of Hertzian contact stresses, cracks would develop slightly below the contact site, then as indentation progresses the cracks would propagate as a result of increase in stress and ultimately cause brittle fracture of the work material under each individual interaction site between the abrasive grits and the work piece. The tool material ought to be specified indentation by the abrasive grits doesn't cause brittle failure. so the tools are made from robust, strong and ductile materials like steel, stainless-steel and different ductile metallic alloys. in addition, abrasive should be created harder.

## Literature review

Adithan and V. C. Venkatesh [1] given the production accuracy for ultrasonically drilled holes affected by the continual wear of the abrasive particles within the slurry and by tool wear. the results of certain necessary parameters like static load, machining time, sort of abrasives, grit size were taken on dimensions of the work and accuracy. it absolutely was all over that the machining accuracy depends to a large extent on the abrasive grit size and to a lesser extent on the amplitude of vibration and therefore the static load. Finer abrasives resulted in reduced outsize and accumulated accuracy of the holes of machined work. M. Komaraiah et al [2] conducted experiments on different work materials –glass, porcelain, ferrite, alumina using numerous tools-metal, stainless-steel, nimonic 80A. The surface roughness of the various work items were analyzed with respect to hardness of the tool material and abrasive used. The results showed that surface roughness decreases with decrease within the grain size and harder tool material provides low surface roughness. R. Singh and Khamba [3] used Taguchi style to model the tool wear rate during unhearable machining of titanium and its alloys. The input parameters such as tool material, power rating, slurry type, grit size, slurry temperature, suspension concentration, were known to give output within the variety of tool wear rate. The interactions among input parameters were thought of for developing the model. The results of the Taguchi model were used for preparing a mathematical model of tool wear rate by Buckingham's theorem.

Dipesh et al.[1] studied design of experiment and regression approach for the applied math analysis of the ultrasonic machining of Glass. The response of the fabric removal rate of the glass was known with the vary of different parameters like power rating, abrasive sort, abrasive size, and suspension concentration. it was found that the grit size was most {significant|most important} parameter and suspension concentration was the least significant parameter and having minimum contribution to the MRR it absolutely was put together observed that the inorganic compound have extra impact on MRR as compared to the mixture of corundum + carbide. The hr power rating resulted in higher MRR as compared to twenty and four-hundredth suspension concentration. This would possibly result to that extra power rating may lead to extra erosion of the work. The grit size of 280 resulted in additional MRR as compared to the 400 and 600 grit size. V. Kumar and Khamba [5] applied the Taguchi multi-objective technique for deciding the optimum combination of varied input factors like sort of abrasive slurry, their size, suspension concentration, tool material, and power rating of unhearable machine for ductile chip formation within the machining of co primarily based super alloy like satellite work material. The optimum parameter values obtained were: Tool material; Titan thirty one, Abrasive slurry; B4C, slurry concentration; half-hour, grit size; 220 and power rating; a hundred twenty five W. J. Kumar and Khamba [6] evaluated the metal removal rate below the governable experimental condition-power rating, tool/abrasive sort, abrasive size, and slurry concentration. A macro model was developed by applying the Taguchi technique. The outcomes of the macro study was used for additional development of the small model by using Buckingham's theorem that was used for predicting metal removal rate in terms of tool hardness, power rating and suspension hardness factors. it absolutely was found that MRR in unhearable of metal is directly associated with the energy input rate for the particular method setting. A high level of input energy rate promotes the brittle fracture of the surface.

R. S. Jadoun et al [7] investigated the impact of process parameters on the ratio of material removal rate to tool wear rate by the Taguchi model. The machining was distributed on the alumina primarily based ceramic with carbide abrasive. The Parameters considered were work piece material, tool material, grit size, power rating, and slurry concentration. The outcomes of the analysis were that cutting quantitative relation decreases with increase in corundum content within the work piece and reduce in power ratio. The cutting quantitative relation will increase sharply as grit size will increase from 220 to 320 grit size. Dam et al [8] investigated impact of unhearable machining on production rate, tool wear, and surface quality of ceramics. it absolutely was found that for robust material the low productivity, high tool wear and low surface roughness ar obtained. For brittle material the relationship is reverse; high productivity, low tool wear rate and high surface roughness ar obtained. it absolutely was conjointly found that the lesser machining rate tends to give a lesser surface roughness. R. chakravorty et al. [9] used four strategies like weighted {signal-to-noise|signal-to-noise quantitative relation|signal/noise ratio|signal/noise|S/N|ratio} (WSN) ratio methodology, gray Relation Analysis, multi-response {signal-to-noise|signal-to-noise quantitative relation|signal/noise ratio|signal/noise|S/N|ratio} (MRSN) ratio, (UT) utility theory strategies for optimizing multiple response of unhearable machining and compared with the relative performance of those strategies. The results showed that WSN or UT method provides higher optimisation performance for unhearable machining and WSN methodology is desirable to the UT methodology as a result of it involves lesser procedure complexity. M. A. Majeed et al [10] used acoustic emission observation whereas unhearable machining of $Al_2O_3/LaPO_4$. The metal removal rate and microstructure of labor material were analyzed using totally different shapes of tool. boron carbide as abrasive with grit size -280 mixed with water in quantitative relation 1:3 was thought of as machining setting. The results found that with the utilization of hollow tool as compared to the solid tool provides associate considerable enhancement in metal removal rate.

H. Lalchhuanvela et al [11] used central composite second order rotatable style for ultrasonic drilling of high alumina ceramic. Response surface methodology was utilized for developing mathematical models of metal removal rate and surface roughness. The abrasive grit size, slurry concentration, power rating, tool feed rate, and suspension flow were thought of as machining parameters. Material removal rate and surface roughness was evaluated by using the analysis of variance. The results showed that higher level of suspension concentration, suspension flow, and better abrasive grain high power rating provides higher MRR. The surface roughness diminished with decrease of suspension concentration, suspension flow, and better abrasive grain. B.L. Ramu et al. [12] investigated tool penetration rate and tool wear rate below the many parameters like abrasive of boron carbide of 280 grit, suspension characteristics, and totally different tool material with static loading. oxide ceramic and cold impact corundum were taken as work piece in unhearable drilling. It used piezoelectric crystal type measuring instrument for measurement the dynamic forces on work items and gear materials. it absolutely was found that higher hardness of $Zro_2$ results in lower material removal rate as compare to $Al_2O_3$.

Adithan and Krishnamurthy [13] investigated the surface integrity of glass workpieces by diffraction. The abrasive sort, abrasive grit size, suspension concentration, amplitude of tool vibration, and frequency were consider as machining parameters. it absolutely was found that with increasing static masses, the out-of-roundness increased at the exit aspect and reduced at the entry of the ultrasonically trained hole. Surface roughness of the outlet increased with increasing static masses. R. S. Jadoun et al [14] investigated the impact of method parameters on the production accuracy (hole outsize, out-of-roundness and conicity) obtained through unhearable drilling of holes in corundum primarily based ceramics exploitation carbide abrasive victimization the Taguchi model. The machining was distributed on the corundum primarily based ceramic with silicon carbide abrasive. The parameters considered were work piece material, tool material, grit size, power rating, and suspension concentration. The best levels of varied method parameters for minimum out-of-roundness were: work piece material; 70th alumina, Tool; tungsten carbide, Grit size; five hundred, Power rating; four-hundredth, slurry concentration; half-hour and therefore the best levels of varied method parameters for minimum conicity were: work piece material 500th aluminum oxide, Tool; tungsten inorganic compound, Grit size; 500, Power rating; four-hundredth, suspension concentration ; 25th.

Dvivedi and Kumar [15] used Taguchi methodology for experimentation and analysis of surface quality in unhearable machining of pure metal and metal alloy. it absolutely was found that the impact of suspension concentration and abrasive grit has vie a big role on the surface end of metal work piece. Surface roughness increased with a rise in abrasive suspension concentration. Kainth et al. [16] projected a static and complex model exploitation the abrasive particle size distribution. associate analysis was distributed considering the non uniformity of abrasive grains to assess the relation between the removal rate and static load/amplitude. Its calculations yielded or so a linear relation between material removal rate and static load. Abrasive grains were assumed to be spherical, whereas truly the grains were of associate irregular form. The amplitude of vibration was remained constant with increase in static load. it absolutely was found that foreseen linear relationship between MRR and static force F that was much not true. foreseen linear increase in with grain size, whereas and optimum price exists. Theoretical machining rate was over sensible values. M. A. Majeed et al [17] used acoustic emission observation for unhearable machining of Al2O3/LaPO4 composite with numerous proportion vary of LaPO4 content. The machinability was analyzed with the various parameters like abrasive of boron inorganic compound with mounted grit size and thirty third of suspension concentration. Low steel was taken as tool material. The outcomes found that with the use of the a lot of proportion of LaPO4 content material in composite, machinability in addition will increase. Power spectra associated with observation acoustic emission clearly indicated smart machinability at the side of 70: thirty composite.

T.C. Lee and C.W. Chan [21] found the amplitude of the tool tip, the static load applied and therefore the size of the abrasive effects on the fabric removal rate and therefore the surface roughness. The micrographs were accustomed value the many effects of the given parameters on the metal removal rate and surface roughness. it absolutely was all over that static load applied and therefore the grit size of the abrasive resulted in a rise within the material removal rate and a roughening of the machined surface. Chander Nath et al. [22] studied the influence of the fabric removal mechanism on hole- integrity of structural ceramics like carbide, alumina, Zirconia. differing types of tool were used with the constant parameters of the unhearable machine for study of metal removal rate, longitudinal and diametrical wear. it absolutely was found that the fabric inside the lateral gap of the hole was removed by the angle penetration and therefore the rolling actions of the abrasives. each the entrance chipping and therefore the wall integrity of USM holes were as a result of the radial and lateral cracks that propagate away from the tool edge within the radial direction. At the highest surface of the hole-cavity, the remaining portion of the cracks was appeared as entrance chipping.

Komaraiah and P. N. Reddy [23] conducted the experiments to review the influence of static loading, tool hardness in each the standard and rotary USM modes keeping all alternative parameters constant. Mild steel, titanium, stainless-steel, silver steel, Nimonic-80A, maraging steel and impregnate wolfram were taken as tool materials. it absolutely was found that the fabric removal rate will increase with increase within the hardness of the tool material. The diametric wear resistance will increase with increase within the hardness of the tool material. The roughness of the machined surface decreases with the utilization of a more durable tool material. The brittleness ratio of the work material influences the roughness of the machined surface. The lower the breakableness ratio, lower the surface roughness. P.L. Guzzo et al. [24] studied totally different brittle and arduous materials (Alumina, ferrite, Lif, Quartz, soda-lime glass, zirconia) to reveal the influence of structural and mechanical properties of work materials on the speed of fabric removal and therefore the topography of machined surfaces. The roughness profiles were measured with a Rank Taylor Robson profilometer. Scanning microscopy (SEM) was utilized to characterize the micromechanisms associated with material removal under unhearable abrasion condition. it absolutely was determined that the speed of fabric removal was short attenuated with the machining depth for work materials within which hardness was at the same order of magnitude than the hardness of abrasive grits.

Soundararajan and radhakrishnan [25]showed that direct pound of the abrasive particles on the work by the tool, leading to material removal and particle crushing, could contributes up to eighty exploit the stock removal in brittle solids like glass. Cavitation effects from the abrasive suspension and natural action related to the fluid utilized are rumored as minor material removal mechanisms. Material removal rate, surface end and machining accuracy ar influenced by various operational parameters like amplitude and frequency of unhearable oscillations, static load applied on the sonotrode, tool style, hardness and size of abrasive particles. H. Hocheng et al. [26] distributed experiments on oxide ceramic for locating metal removal rate, hole clearance, surface roughness, tool wear rate of the work. The results found that the metal removal rate will increase with the increase of amplitude of the unhearable machine. At constant amplitude, the clearance decreases with applied load. higher surface roughness are often obtained by the five hundred vary of amplitude. a rise in applied load results in decrease in hole clearance. and therefore the larger the static load is favorable for a finer surface. M. Ramulu [27] investigated the impact of suspension hardness on metal removal rate of carbide ceramics with the many parameters like work material properties, tool properties, amplitude of vibration and static load. it absolutely was all over that use of boron inorganic compound abrasive resulted in material removal rates that were or so seventy fifth over the carbide abrasive for the four hundred grit size and 320% higher for 220 grit size whereas machining carbide ceramics.

D. Jianxin and L. Taichiu [28] investigated the properties and microstructure from the work materials concerning the MRR and surface roughness in unhearable machining related to alumina-based ceramic composites ($Al_2O_3$/TiC, $Al_2O_3$/$TiB_2$, $Al_2O_3$/ (Ti, W). it absolutely was found that the composites with high fracture toughness showed lower MRR whereas the particle reinforced ceramic composites showed the upper MRR and surface roughness. The whisker orientation vie a vital role on the MRR. because the direction angle ranged from 0° to 90°, a decrease in MRR was determined. The angle up to 90° resulted smallest MRR, and therefore the angle up to 0° resulted higher MRR. B. Ghahramani and Z. Y. Wang [29] investigated methodology mechanism and dynamics of unhearable machining. The photoelastic technique was utilized to simulate the tool inside the unhearable machining method by impacting a grit particle in-tuned with the work. the target of this check was related to the stresses developed inside the submersed of associate $Al_2O_3$ work (material) beat by one abrasive particle owing to the force of the moving tool and to analyze the characteristics concerned inside the fabric removal methodology throughout unhearable machining. Experimental simulations were done to research the mechanisms of fabric removal involving the dynamic impacts of the abrasives from the high-frequency vibrations and conjointly the impact mechanism of abrasives forced by the pound action of the moving tool. Simulation testing of the fabric removal mechanisms involved inside the USM methodology {may be|could conjointly be|is also} associate applicable technique for obtaining essential knowledge with regard to material morphology and also the strain characteristics at the submersed.

## Conclusions and future scope

USM method is only depends on the work material properties chiefly hardness and fracture toughness, tool properties (hardness, impact strength and finish), abrasive properties (hardness, coarseness and viscosity) and method settings (power input, static load, amplitude and frequency of vibration). The success in terms of MRR and Surface roughness strictly depends on the choice of machining method parameters. correct choice of method parameters plays a big role in making certain the product quality, reducing the machining value, increasing productivity. The machining of materials like Glass, super alloys, ceramics, tungsten carbide etc. to their final dimension by standard methods is very robust and usually not possible. to beat such quite issues USM are often utilised. Some others materials i.e.titanium, metal alloys and alternative harder and more durable materials like nickel alloys, crystalline diamond compact etc for his or her wide application within the numerous reasonably trade.

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