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TURNING AND DRILLING STUDIES ON ALUMINIUM MATRIX COMPOSITES-A REVIEW

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ABSTRACT

Aluminium metal matrix composites are likely to alternative for ferrous materials due to enhanced properties. Generally, the composites are received wide spread attention due to its superior properties like specific strength, good wear resistance, elevated strength, weight to strength ratio, density and thermal conductivity. These properties are suitable for automobile, aerospace, space, shipbuilding and structural applications. This paper investigates the cutting characteristics of aluminium metal matrix composites during turning and drilling processes. The analysis of the review clearly indicates that the drilling parameters like spindle speed, feed rate and tool geometry are offers significant influence on the material removal rate, tool wear, delamination, surface roughness, torque and thrust. It is also observed from the review, the turning parameters such as cutting speed, feed rate, depth of cut and tool geometry are also tenders considerable effect on cutting force, surface integrity, flank wear, temperature of tool, material removal rate and tool vibration.

Keywords- *Aluminium Matrix Composite, Drilling, Turning, Process parameters, Responses*

I. INTRODUCTION

Metal matrix composites are made by combining two or more metals in which outstanding properties are achieved which makes to suit industrial application. These composites are fabricated by using of whiskers, fibers, and particulate as reinforcement materials. Usually, the composites have attractive properties like high specific strength, specific stiffness, damping properties, résistance to wear, low thermal conductivity and low thermal expansion. These properties are well appreciated by the automotive and aerospace applications. In spite of many attractive properties, the application of these materials widely restricted due to poor machinability, formability and weldability. The existences of the abrasive reinforcement in the composites are responsible for numerous machining challenges for the industry community.

The present literature review explores the various process parameters, responses, effect of processes parameter on drilling and turning responses. During drilling operation the change in drill point geometry strongly influence the quality characteristics of the drilled hole. SEM images and contour plots of drilled hole wall have been used to qualitatively explain the delamination of the composites. The chip formation mechanism observed during drilling also establishes the cutting behaviour of the composites.

And coming to the turning, the influence of machining parameters, e.g. cutting speed, feed and depth of cut on the cutting force components, namely

Feed force cutting force and radial force has been investigated. Investigations have studied A comparison was made between there reinforced and unreinforced composites. The results proved that all the cutting force components decrease with the increase in the weight percentage of the reinforcement: this was probably due to the dislocation densities generated from the thermal mismatch between the reinforcement and the matrix Experimental evidence also showed that built-up edge (BUE) is formed during machining of low percentage reinforced composites at high speed and high depth of cut. The formation of BUE was captured by SEM, therefore confirming the result. The decrease of cutting force components with lower cutting speed and higher feed and depth of cut was also highlighted.

II. LITERATURE REVIEW FOR DRILLING

A.Mahamani. (2014) [1] have made an attempt for analysis and synthesis of in-situ metal matrix composite of AA2219-TiB2/ZrB2 flux- assisted synthesis method by different reinforcement ratio. These results proved by micro-structural analysis, scanning electronic microscopic (SEM) analysis and the chemical composition of matrix observed through EDAX analysis. The results obtained from the experiments improved the strength composite increases with different reinforcement ratio and the effect of machining of parameters like spindle speed, feed rate, point angle (cutting edge angle) of the drill bit on output characteristics like surface roughness (Ra) and delamination composite with varying reinforcement ratios. the point angle is less than the conventional drill the surface roughness (Ra) is minimum coming to delamination factor with increasing of spindle speed, feed rate which is increased from the experiments.A.Taskesen.et al (2013) [2] conducted drilling experiments on (B4C) reinforced aluminium alloy by using Taguchi orthogonal array for the Evaluation of out parameter like tool wear and size error of drilled hole with varying of processes parameter of % of B4C reinforcement, feed rate, spindle speed and drill material like TiAlN coated carbide tool, carbide tool , high-speed steel. From the experimentation the output responses to evaluated like abrasive wear of tool, the formation of built- up edge of toll due to high temperature in machining process and flank wear of tool. and also conducted scanning electronic microscopic (SEM) analysis for material drill tool for finding carbide dispersion and flank wear ,surface wear respectively .This paper concludes the tool wear is increased by particle mass fraction reduced in with feed force and speed do not have the significant effect on output characteristic high amount of built up edge formed in HSS and less amount in TiAlN coated tool Built edge formation increase in the feed rate of the tool when particle mass fraction is reduced. Sarbjit Singh (2016) [3] presented an experimental work on drilling of aluminium (6063/10% SiC MMC), by manufacturing of composite by stir casting process. In this investigation focussed the various drill tool geometry, lip angle of a drill tool on drilling quality characteristics. In this article presents the experimental investigation for minimizing of output parameters like specific cutting pressure and surface roughness (Ra) of drilled hole wall varying input parameter like Varying step diameter of drill bit and point angle the results obtained from the photometric analysis like SEM analysis and contour plots of drilled holes and the influence of second cutting angle were analyzed further the analysis variance has preferred for find out the most influential parameter on the output parameter and from the analysis the mechanism of avoiding of burr formation eliminated by using the second angle of drill bits .Masato Okada.et al (2014) [4] conducted drilling studies in order to evaluate output characteristics through a novel method manufactured drill reamer.This innovative nomenclature can perform drilling semi-finishing and finishing operation simultaneously in one after another which is compared with conventional drill tool and drill reamer agreement between the output character like thrust force ,cutting forces, surface roughness of drilled hole ,wear behaviour of cutting tool and cutting edge temperature which can study under dry and mist lubrication condition from the results of this experimentation, it is found that the cutting edge temperature of drill bit is increased to 430ºC and the temperature difference between the drill edge of drill reamer was higher than the cutting edge temperature is 800-1000ºC.the experimental investigation proved that the oil mist decreases the thrust force of drill reamer compared to conventional drill toll the thrust force is maximum of drill reamer in dry cutting compare to conventional drill tool. Gul Tosun et al (2011) [5] presents a statistical analysis of process parameters for surface roughness in the drilling of Al/SiCp metal matrix composite from his investigation. The experimental studies were conducted under varying spindle speed, feed rate, drill type, point angle of the drill, and heat treatment. The settings of drilling parameters were determined by using Taguchi experimental design method. The level of importance of the drilling parameters is determined by using analysis of variance. The optimum drilling parameter combination was obtained by using the analysis of signal-to-noise ratio. Statistical analysis of response variables and signal-to-noise ratios are revels that the feed rate and tool type are significant factors. Confirmation tests verified that the selected optimal combination of process parameter through Taguchi design was able to achieve desired surface roughness. Nilrudra Mandal,et al (2011) [6] investigates the wear behaviour of 6061 Al-alloy/SiC with 10 vol.% SiCp against hardened and tempered AISI 4340 steel under combined rolling-sliding conditions. L23 full factorial design of experiments have been carried out to see the effect of few parameters, i.e., contact stress, speed and duration with respect to wear. The interaction effect has also been studied by 3D graphical contours. A mathematical model is developed using regression analysis technique for prediction of wear behavior of the MMC and adequacy of the model has been validated using analysis of variance (ANOVA) techniques. Finally, the optimization of the parameter has also been done using Design Expert software. The results have shown that Response Surface Methodology (RSM) is an effective tool for prediction of wears behaviour under combined sliding and rolling action. It is also found that the wear of MMC is much lower than hardened; tempered AISI 4340 steel and rolling

speed has the maximum influence in wear of both materials under investigation. Gul Tosun ,et al (2003) [7] deals with the surface integrity of drilled Al/17%SiC particulate MMCs. Dry drilling tests, at different spindle speed, feed rates, drills, point angles of drill and heat treatment, were conducted in order to investigate the effect of the various cutting parameters on the surface quality and the extent of the deformation of drilled surface due to drilling. For this reason, the surface roughness of the workpiece material was investigated after drilling operations. The work piece material was drilled in four heat treatment conditions: as-received, solution treated, and solution treated and aged for 4 and 24 h. The drills used were 5 mm diameter, and various point angles. The experiments were performed under conditions the different speeds of 260 and 1330 rpm and the feed rates of 0.08 and 0.16 mm/rev. Drilling tests were carried out using high-speed steel (HSS), TiN coated HSS and solid carbide drills. In the experimental results, it is determined that increasing drill hardness and feed rate decrease the surface roughness of drilled surface for all heat treated conditions. In addition, the optimum surface roughness was determined when the solid carbide drill tools were used on the specimens with packaged condition. S. Basavarajappa,et al (2008) [8] discussed the influence of cutting parameters on drilling characteristics of hybrid metal matrix composites (MMCs)-Al2219/15SiCp and Al2219/15SiCp–3Gr. The composites are fabricated using stir casting method. The Taguchi design of experiments and analysis of variance (ANOVA) are employed to analyze the drilling characteristics of these composites. The experiments were conducted to study the effect of spindle speed and feed rate on feed force, surface finish and burr height using solid carbide multifaceted drills of 5mm diameter. The results reveal that the dependent variables are greatly influenced by the feed rate rather than the speed for both the composites. The ceramic–graphite reinforced composite has better machinability than those reinforced with SiCp composites. S. Basavarajappa, et al (2007) [9] the main concern in the present study is the surface roughness variations on the drilled surface and extension of surface and subsurface deformation due to drilling. The influence of different tools and cutting conditions on Al2219/15%SiCp and Al2219/15%SiCp- 3%Graphite (hybrid) composites is investigated experimentally. The composites are fabricated by liquid metallurgy method. The drilling tests are conducted with carbide and coated carbide tools. The surface roughness decreases with the increase in cutting speed and increases with the increase in feed rate. The surface is analyzed using scanning electron microscope (SEM). Micro hardness profiles indicate that the subsurface deformation extends up to a maximum of 120 mm below the machined surface for Al2219/15SiCp-3Gr composite when compared to 150 mm in Al2219/15SiCp composite.S. Kannana, et al (2009) [10] to clearly understand the role played by the ductile matrix on the machining performance based on the estimation of line defects generated as a result of cutting. The micro structural studies were conducted using transmission electron microscopy (TEM) on the machined surface to reveal the deformation pattern of the work hardening matrix and its correlation with the forces generated during turning MMCs. Cracking and deboning of the reinforcement particles are the significant damage modes that directly affect the tool performance. It was found that the particle size and volume fraction affect the extent of deformation of the generated surface. Also, the machining forces are correlated to the plastic deformation characteristics of the matrix material. This investigation provided valuable information on the deformation behaviour of particulate reinforced composites that can improve the performance and accuracy of machining MMCs.

Y. Sahin,et al (2003)[11] at different cutting conditions. Experiments were carried out with TiN coated carbide tools and TP30 coated carbide tools at various cutting speeds. Tool wear and surface roughness in the turning of Al2O3 particle-reinforced aluminium alloy composite was investigated with special attention paid to the effects of material structures. The experimental results showed that tool life increased with increasing the cutting speed for both cutting tools and the tool life of TiN tool was significantly longer than that of TP30 tool. It is observed that the major wear form of the tools is the combination of rounding of nose and flank wear in addition to removal of coated layer from the substrate for the TiN tool but edge chipping and rounding of the nose was evident for the TP30 tool. Moreover, the optimum surface roughness was obtained at a speed of 160 m/min while the maximum surface roughness value was found in the machining of the 10% Al2O3 composites with the particle size of 16 mm. The surface roughness also increased with the increasing weight percentage of the particles. Furthermore, the physical appearance of chips produced by TiN cutting tools was discontinuous and smaller sizes while the appearance of chips produced by TP30 cutting tools was continuous type and larger size.

III. LITERATURE REVIEW FOR TURNING

V.Auradi et al (2014) [12] Conducted experimental investigation on manufactured of metal matrix composite with 11 Wt% B4c particulate reinforced with 6061 aluminium matrix .in this processes introduced two-stage processes at first stage the material heated 7500c and (K2TiF6) salt introduced after B4c particulates are added to the metal .from the experimentation the uniform dispersion of B4c composite without clustering in AA 6061 matrix was evidence from the SEM/EDAX and XRD analysis from the results the mechanical properties improved the base metal. N.Radhika et al. (2013) [13] discussed the surface integrity and temperature of the tool during turning operation.AL-SiC/10Mg alloy reinforced with various wt % of alumina along with 3 wt% of graphite prepared by stir casting method has been evaluated. In the investigation processes, the processes parameters considered like speed, feed, and depth of cut over the surface integrity and tool and temperature of the tool were analyzed through analysis of variance. From this statistical analysis, the percentage of contribution of each parameter evaluated and finally the optimal run adopted for maximization of surface integrity.Asok Kumar Sahoo.et al (2013) [14] investigated the flank wear and surface roughness of during CNC turning of Al/SiCp metal matrix composite using uncoated tungsten carbide inserts under dry condition for the conducting the experiments L9 Taguchi orthogonal array adopted to investigate the adhesion and abrasion wear were analyzed by image processing analysis .from the results it has been observed built-up edge formation on tool due to high speed and high feed rate which cause the adverse effect on the surface integrity of work piece .for the minimization of flank wear and surface roughness the optimal condition are found it has been proved that are statistic significant. S.B.Venkata Siva et al (2014) [15] A novel in-situ method is adopted to fabricate the metal matrix composite. in this method, mines waste colliery shell material used as the reinforcement material. These results from the improvement of mechanical properties compared with Al-Al2O3, AL –AL2O3-SiC composite. For the experimentation processes, parameters are considered radial force, feed force, cutting force to optimize the power consumption and surface roughness are taken as the index for Machinability from the research analyzed the Machinability of composite has good Machinability index compared with remains composite .for analyzing the chemical properties XRD,SEM analysis were conducted.M.V.Ramesh.et al (2014) [16] conducted experimental analysis AA6061/15SiCp with the diamond tool for analyzing the processes parameter. From the analysis the sic particle which causes the fluctuation and cutting forces. And developed a nonlinear regression equation model from the analysis it has been found that a good correlation between the actual and predicted values. This correlation causes to minimizing the cutting fluctuation and cutting forces.

D.Saichaitanya Kishore et al (2014) [17] was investigated the cutting forces and surface roughness during turning of Al6061-TiC composite with different reinforcement ratio of 0%, 2%, and 4% of TiC as reinforcement. For the conducting experiment Taguchi L_{25} orthogonal adopted during the experimentation the processes parameters are considered such as cutting speed, feed rate and depth of cut and output responses considered cutting forces and surface roughness and flank wear of tool zone investigated .finally SEM, EDAX analysis, and micro hardness analysis were conducted for material for finding of uniform dispersion of TiC particles. Dora Siva Prasad et al (2014) [18] in this present investigation of the mechanical properties of double stir cast composite various volume fractions and SiC particulate. From the examination of manufactured composite it has been observed that with increasing volume fraction the porosity and hardness of composite are increasing, the ultimate tensile strength, yield strength elongation were decreasing. And dislocation density of composite is increasing with increasing reinforcement SEM analysis and XRD analysis were conducted for to examine uniform dispersion of reinforcement. V.Sivanath et al (2014) [19] in this paper studied fatigue behaviour of unreinforced and reinforced behaviours composite with different reinforcement ratio (10, 12, and 15) weight % with a grain size of 325 mesh. In the present investigation the specimens prepared as per the ASTM standard and conducted tensile, fatigue, impact test for the investigation to find the effect of reinforcement. SEM and XRD were conducted to particulate distribution over the aluminium matrix. P.Suresh et al (2014) [20] investigated the Tribological and Machinability studies on hybrid metal matrix composite with adding of graphite as reinforcement wit 5%, 7.5%, 10% of equal mass fraction .during the machining processes the output parameter were investigated like Metal removal rate, surface roughness, flank wear for multiple response optimization grey and grey-fuzzy analysis opted to set the optimum parameter for cutting of composite at low magnification and high magnification rate. Deepak Kumar.et al (2015) [21] this paper emphasizes the Machinability characteristics of a This formed A356-5TiB2 reinforced metal matrix composite during the turning processes in this investigation the impact processes parameter considered cutting speed and feed, depth of cut against the surface during the investigation

to field out the tool wear and effect of TiB2 reinforcement to be carried out the formation of chip mechanism were observed by conducting SEM analysis on the chip.

IV. CONCLUSION

This review of literatures on the various aspects of machinability behaviour of the aluminium matrix composites provides several conclusions.

In turning process, the increase in cutting speed decreases the surface roughness, increase the tool wear, decrease cutting force and increase the temperature.

Increase in feed rate increase the surface roughness, cutting force, tool wear and temperature. In drilling process, the increase spindle speed increases the torque, decrease the surface finish and increase the thrust force.

The tool geometry for the both turning and drilling tool offers significant influence on the responses.

Majority studies and analysis of variance shows that, the feed rate has strongest effect on the responses for both drilling and turning process.

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REFERENCES

1. *Mahamani.A., Experimental investigation on drilling of Aa2219-TiB2/ZrB2 In-Situ Metal matrix composite. procedia material science (2014) 6 pp-950-960.*
2. *Taskeseen .A., Analysis and optimization of drilling parameters for dimensional accuracy in B4C reinforced Al-alloy. Trans. Non-ferrous Met. Soc. China.(2013)pp2524-2536.*
3. *Sarbjit singh., Effect of modified drill point geometry on drilling quality characteristics of metal matrix composite (MMCs) .journal of mechanical science and technology.(2016)30(6)pp2691-2698.*
4. *Masato Okada.,Naoki Asakawa ., Cutting characteristics of twist drill having cutting edges for drilling and reaming .journal of mechanical science and technology (2014)28(5)pp1951-1959.*
5. *Gul Tosun. Statistical analysis of process parameters in drilling of AL/SICP metal matrix composite, Int J Adv Manuf Technol (2011) 55:477–485.*
6. *Nilrudra Mandal, H. Roy. Mathematical Modeling of Wear Characteristics of 6061 Al-Alloy-SiCp Composite Using Response Surface Methodology. Journal of Materials Engineering and Performance10.1007/s11665-011-9890-7 .*
7. *Gul Tosun, Mehtap Muratoglu. The drilling of Al/SiCp metal–matrix composites. Part II: work piece surface integrity Composites Science and Technology.64 (2004) pp.1413–1418. .*
8. *Basavarajappa,S Chandramohan,.G. Some studies on drilling of hybrid metal matrix composites based on Taguchi techniques. Journal of materials processing technology, 1 9 6 (2008) 332–338.*
9. *Basavarajappa,S Chandramohan.G, Drilling of hybrid metal matrix composites—Work piece surface integrity", International Journal of Machine Tools & Manufacture 47 (2007) 92–96.*
10. *Kannana S., Kishawya, H.A., Cutting forces and TEM analysis of the generated surface during machining metal matrix composites journal of materials processing technology 2 0 9 (2009) 2260–2269.*
11. *Sahin.Y, Kok.M, Tool wear and surface roughness of Al2O3 particle-reinforced aluminium alloy composites" Journal of Materials Processing Technology 128 (2002) 280–291.*
12. *Auradi.V,Rajesh G.L and S.A.Kori .Processing of B4C Particulate Reinforced 6061 Aluminium Matrix Composites by melt stirring involving two-step addition. Procedia Material Science (2014)6 pp1068-1076.*
13. *Radhika.,N and Subramaniam.R.,Machining Parameter optimisation of an aluminium hybrid metal matrix composite by statistical modelling. Industrial lubrication and tribology (2013) 65/6 pp-425-435.*

14. *Ashok Kumar Sahoo,Swastic Pradhan.,Modelling and optimization of AL/SiCp MMC machining using Taguchi approach .Measurement (2013) 46 ,3064-3072.*
15. *Venkata Siva .S.B., Ganguli.R.I., Machinability of Aluminium Metal Matrix composite reinforced with in-Situ Ceramic composite developed from mines waste colliery Shale Material and manufacturing processes (2013), 28:1082-1088.*
16. *Ramesh. M.V., Lee.W.B., A Parametric Analysis of Cutting Forces in Single Point Diamond turning of A16061/SiCp Metal Matrix composites (MMCs)Material and Manufacturing Processes (2001), 16(1), pp-61-78.*
17. *Sai Chaitanya Kishore. D., K.Prahlada Rao., Investigation Cutting force, Surface roughness and flank wear in turning of In-SiTu A16061-TiC Metal Matrix composite Procedia Material Science (2014)6 pp-1040-1050.*
18. *Siva Prasad. Dora.,shoba .chintada., Investigation on mechanical properties of aluminium hybrid composites .Journal of material research and technology Journal of material research technology .2010*
19. *Suresh.P., K.Marimuthu, Optimization of machining and parameter in turning of Al-SiC-Gr hybrid metal matrix composites using grey-fuzzy algorithemTrans.non ferrous Material .society .china (2014)24pp-2805-2814.*
20. *Depakkumar.s.,Pandu R.Vunduvalli, Optimization of process parameters during Machining of Thixoformed A356-5TiB2in-situ composite using Design of Experiments International Conference on robotics, Automation, Control and Embedded Systems –RACE 2015, Hindustan University ,Chennai, India.*