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STUDIES ON THE INFLUENCE OF DRILLING CYCLE ON THE SURFACE ROUGHNESS OF THE DRILLED HOLES

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ABSTRACT

Tool wear is a an major issue and challenging task for engineers since wear on the drill increases the surface roughness, affects the hole quality, decreases the tool life and also increases the production cost. As one third of the metal removal process performed in industries is drilling operation, in this paper an experimental investigation was conducted to analyze the influence of drilling cycle on the surface roughness of the drilled holes during drilling deep through holes on the prepared aluminium metal matrix composites. The composites were prepared by using stir casting method. The experiments were carried out both in wet and dry condition using cobalt coated Φ5mm HSS drill.G83 peck drilling cycle and G81 drilling cycle was selected to drill deep through holes on the prepared aluminium metal matrix composites.

Keywords: surface roughness, production cost, tools, drilling cycle.

INTRODUCTION

Drilling is one of machining process which is carried out in the final processing stage before assembly [1]. The mechanical properties of the workpiece may be affected by the drilling process as it creates a low residual stress around the hole opening and the work piece becomes more susceptible to corrosion at the stressed surface [2]. Apart from the conventional machining methods, deep holes can also be produced by unconventional machining process like Electro Discharge Machining (EDM), Electron Beam Machining (EBM), Laser drilling and Electro Chemical Machining (ECM) [3]. However, due to certain limitations like high cost, need of conducting material in EDM process and precise control of chemical reaction in electro chemical machining process the conventional machining process is found to be an economical method for drilling deep holes [4].

The major concern with machining of alumina reinforced AMMCs is the extreme tool wear caused due to the abrasive action of the ceramic particles and becomes cost sensitive because of their high machining cost [5]. AMMCs have the properties like high strength; high stiffness, high thermal conductivity and combined properties like wear resistance with fracture toughness and high strength with corrosion resistance. These combined properties present in the AMMC are not found in the existing monolithic materials [6, 7].However, machining of these newly developed composite materials are difficult due to the presence of hard reinforced ceramic materials.

In order to overcome this problem, near-net-shape manufacturing technique like powder metallurgy, die casting, injection molding techniques are used .Near net shape manufacturing technique can produce components which are very close to the final net shape. It can reduce the machining time and production cost compared to the traditional manufacturing techniques. However, inspite of using near net shape technique the required shape and dimension of the component cannot be achieved by completely eliminating the machining process [8].

The unavailability of comprehensive machinabilty data for the metal matrix composites (MMC's) using the conventional methods results in frequent and expensive tool changes and it eventually leads to increased job completion time [9]. In this regard, more number of experimental studies is needed to identify the drawbacks in the existing conventional drills during machining of these newly developed composite materials.

In this work, Aluminum 6063 alloy was taken as the matrix alloy as it is widely used in industries. Aluminum 6063 alloy is known as an extrusion alloy and is typically used widely in architectural applications.Al6063 was taken as the base matrix which is reinforced with 15% wt of quarry dust particles. From the preliminary studies carried out by [10, 11] the chemical composition of quarry dust contain Sio2, Al2O3, Cao and Fe2O3 as the major elements.

Our main objective of the present work is to investigate on the influence of drilling cycle on the surface roughness of the drilled holes on the prepared Aluminium Metal Matrix Composite material using Φ5mm cobalt coated HSS drills both in wet and dry conditions.

Material Preparation

The composite material used in this work is prepared by stir casting method. AL 6063 matrix alloy was selected as the base matrix which is reinforced with 15% wt of quarry dust particles with an average particle size of 400 mesh size. The chemical composition of Aluminium 6063 alloy is listed in Table-1.

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Table-1. Chemical composition of aluminium 6063 alloy.

Al	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ca
98.95	0.303	0.071	0.0050	0.0759	0.529	0.0037	0.014	0.025	0.0151	0.0146

The Quarry dust stone particles were initially preheated to a temperature of 250°c and was added in two steps into the vortex of the molten AL 6063 alloy. At every stage before and after introduction of the reinforcement particles, the molten alloy was stirred at 400 rpm for a period of 10 minutes using a stirrer. Pouring temperature of 750°c was adopted and the molten composite was then cast into the prepared rectangular block sand moulds. Before pouring into the mould, the molten composite was degasified using solid hexachloroethane. The molten composite were cast into two rectangular blocks of size (120× 120 × 24 mm). The materials were used for experimentation as cast condition.

Experimental Setup and Procedure

The prepared composite materials were faced and cut to a strip of 100 × 100 × 20 mm size each. The drilling test was performed in AMS 5000S Fanuc control vertical machining center, shown in the Figure-4. Deep through holes were drilled using HSS drill bit. The experiment was conducted both with and without coolant supply. The feed rate was varied from (0.05, 0.15 and 0.25mm/min) for every spindle speed of 3820, 4774, 5728 rpm. The spindle speed and feed rate was selected based on the recommendations of the tool manufacturers.

Figure-1. Experimental set up.

Selection of Drilling Cycle

When the holes drilled on the component are more than four times the diameter of the drill, it is called as deep hole drilling. Deep hole drilling finds its applications in various fields like: Oil and gas exploration equipment, aerospace equipment and engines. In this work the following two drilling cycles G83 and G81 drilling cycles were taken for the investigation.

Deep Hole Drilling Cycle (G83 and G81 drilling cycles)

G83 peck drilling cycle is a multistage drilling operation which is designed to keep the flutes unclogged, clear the chips and to keep the drill cooler. The disadvantage of peck drilling cycles is that they take longer time to finish each hole. It takes time for the tool to feed down, rapid out of the hole, rapid back and feed down again, thus on long production runs, they may be inefficient. G83 peck drilling cycle is a method of drilling deep holes which takes small cuts into the work piece, retracts rapidly to break and clear the chips, rapids back to the last Z depth, makes another small cut, retracts again, and so on until the full Z depth is reached. Whereas G81 drilling cycle is used for normal drilling. The full Z depth is cut in a single pass and the tool is then retracted from the bottom of the hole in rapid traverse.

RESULTS AND DISCUSSIONS

Surface Roughness

In this work, the surface roughness was measured by using surface roughness tester machine PI SURF105, Model-SURFCOM 130A, with 0 - 40 µm range and 0.00125µm resolution.

Variation of surface roughness values for both G83 peck drilling cycle and G81 drilling cycle on the prepared composite with variation in feed rate and cutting speed when drilled with and without coolant supply using Cobalt coated HSS drill are shown in Figures 2 (a) and (b).

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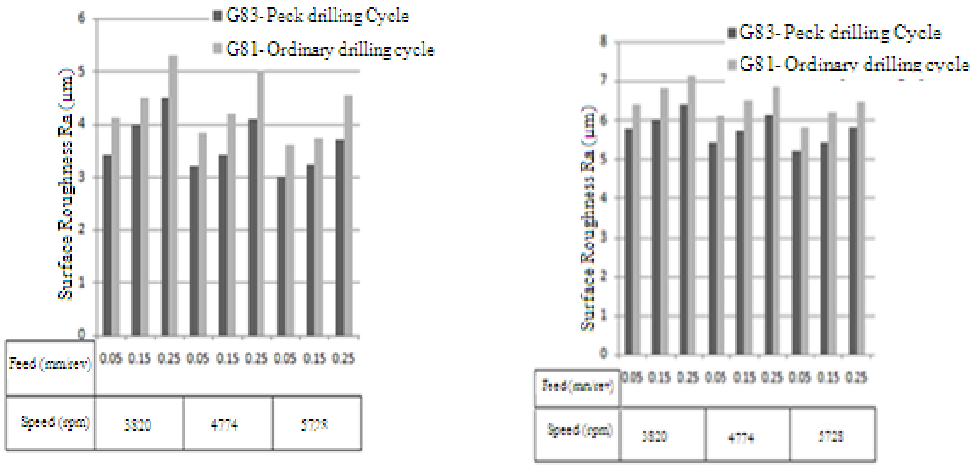

(a) (b)

Figure-2. Shows the variation of surface roughness Vs cutting parameters for cobalt coated HSS drill with coolant supply (a) G83 peck drilling (b) G81 drilling cycle.

It can be clearly seen from Figures 2(a) and (b) that surface roughness increases with increase in feed rate and decreases with increase in cutting speed which correlates with the findings of [12].

From Figure-2(a), it can be seen that maximum surface roughness values of 5.3µm is obtained for G81 drilling cycle and 4.5µm for G83 peck drilling cycle when drilling using cobalt coated HSS drill with a feed rate of 0.25 mm/rev and cutting speed of 3820 rpm. It is clear from Figures 2(a) and (b) that at all cutting conditions the surface roughness of the holes produced by G81 drilling cycle is high compared to G83 peck drilling cycle. When the depth of the hole is more than four times the diameter of the drill, it is difficult to get the coolant to the tip of the drill. Deep-hole drilling cycles (G83 peck drilling cycle) are designed to the break chips so that they are made small enough to flow up through the flutes on the tool without causing damage to the surface of the drilled hole and permit the coolant to reach the bottom of the tool. Thus the surface roughness of the hole drilled by using G83 peck drilling cycle has resulted in very good surface finish which is clear from the Figure-3(b).

On the other hand, G81 drilling cycle the full depth is cut in a single pass without retraction. Thus as there is no retraction, the removed chips get clogged in between the flutes and the surface of the workpiece causing damage to the machined surface. Thus the surface roughness of the holes drilled by using ordinary G81 cycle has very high surface roughness as shown in Figure-3(a).

(a) **(b)**

Figure-3. Shows the surface roughness of the drilled holes at 3820rpm, 0.25feed rate using cobalt coated HSS drill by (a) G81 drilling cycle (b) G83 peck drilling cycle.

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Figure 2(a) and (b) shows the variation of surface roughness values for both G83 peck drilling cycle and G81 drilling cycle when drilled without coolant using cobalt coated HSS drills. From figure 2(b), it can be seen that maximum surface roughness values of 7.1µm is obtained for G81 drilling cycle and 6.3µm for G83 peck drilling cycle when drilled using cobalt coated HSS drill with a feed rate of 0.25 mm/rev and cutting speed of 3820 rpm. In this case also, the surface roughness increases with the increase in feed rate and decreases with increase in spindle speed and the surface roughness of the holes drilled by using G81 drilling cycle was high compared to G83 peck drilling cycle.

CONCLUSIONS

An experimental investigation was conducted to analyze the influence of drilling cycle on the surface roughness of the drilled holes during drilling deep through holes on the prepared aluminium metal matrix composites. Based on the experimental results the following were the observations.

- The coolant supply plays a vital role in improving the surface roughness of the drilled holes.
- Better surface finish was obtained using G83 peck drilling cycle with coolant supply
- The surface finish obtained using G81 drilling cycle was high compared to G83 peck drilling cycle.
- Surface roughness of the drilled holes increases with increase in feed rate and decreases with increase in cutting speed.

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