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A study on drill machining for Magnesium alloy using Taguchi method

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Abstract. Magnesium is one the very important material light weight, especially in the field of the vehicle component, and the field of biomedical. Application of material magnesium and its alloy in the field of biomedical based on the magnesium characteristics which look very much like the nature of biocompatibility of bones in man and melted down within the body. Application material magnesium are also many developed by means of grown (implant). Magnesium alloy material has some of the more in the chemical nature and physics, but in the machining process a magnesium alloy known as combustible metal material type, especially during the machining process at high speed. The optimizing of machining process is necessary in order to maintain for not chip burning. In this research, the point angle, lubricant and drilling parameter were analysed to know their influence on the value of surface roughness, cylindricity and perpendicularity. On this research analysis support for new carried out using a Taguchi Method L18 consisting of 3 factors with 3 levels and 1 factors with 2 levels. The research results show that surface roughness is influenced by the significant contributions from the point angle 18.9 % and lubricant 14.5 %, where the point angle is 650 with lubricant of synthetic oil. The emergence of a nose radius tendency resulting in the increasing level subtlety. Cylindricity is influenced by an point angle 450 of the drilling process however, especially if there is an interactions of the feeding of 0.2 mm/rev and synthetic lubricant. The cutting edge accuracy led to a tangential force so that had an impact on their rotation stability and the cylindricity of drilling results. The value of perpendicularity of magnesium AZ31 in the drilling process however also carried out similar procedures are very much influenced by the cutting parameter of feeding that produces the significance of p = 0,044 , while the strongest significance will be happened if there were an interaction between feeding of 0,1 mm and synthetic lubricant to p = 0.041.

Keywords: drilling, magnesium AZ31, surface roughness, Taguchi method, perpendicularity

1. Introduction

Drilling process is one of the most important cutting processes and has been widely investigated by numerous researches. In fact, drilling operation is not considered as a very crucial factor to influence the quality of machine parts with a good machinability like magnesium alloys [1]. Many researchers have investigated effects of drill bit's geometrical parameter on the quality of machine parts. Chen and Fuh [2] used a split-point drill to develop a force model incorporating the splitting parameters for the drilling process. They optimized drill-point geometry to minimize the thrust force and torque during drilling. Chen and Tsao [3] indicated that drills with different coatings performed differently on the drill life and quality of drilled hole. Haan and Batzer [4] investigated effects of different profiles on the functions of drills. They measured torque produced from varying drilling conditions: cutting speed, feed, on/off in running cutting fluid. They concluded that cutting fluid is a significant factor in producing drilling hole's profile. Besides, cutting fluid affected the amount of BUE (Built-up Edge) depending on the efficiency for cutting fluid removing heat from cutting work piece [5] used the tractable metals and developed empirical expressions for estimating torque and thrust force during drilling process. They indicated that increasing the point angle of drill reduced torque but increased the thrust force. The above information indicates that geometrical factors of drill bits and processing parameters greatly affect the performances of drilling operation.

Magnesium is one the very important material light weight, especially in the field of the vehicle component, and the field of biomedical [6]. Application of material magnesium and its alloy in the field of biomedical based on the magnesium characteristic which look very much like the nature of biocompatibility of bones in man and melted down within the body. Application material magnesium is also many developed by means of grown (implant) [7]. Magnesium alloy material has some of the more in the chemical nature and physics, but in the machining process a magnesium alloy known as combustible metal material type, especially during the machining process at high speed [8 9]. The optimizing of machining process is necessary in order to maintain for not chip burning. In this research, the point angle, lubricant and drilling parameter were analysed to know their influence on the value of surface roughness, cylindricity and perpendicularity.

However, drilling process is a necessary step for making parts. So far, most researchers are trying to prevent the ignition of magnesium scraps through modified the geometry of machining scraps and machining handbooks recommend that drill bit of 700–1180 point angle is suitable for drilling magnesium and magnesium alloys. This study, however, investigated not only the operation parameters, like cutting speed, feed rate and point angle of drill bits on the quality of drill hole, but also the dynamic effects of drilling operation on microstructure of AZ61 [1].

The experiment was carried out on the basic of Taguchi's L18 Orthogonal Array of experiments. The important input drilling parameters were chosen as spindle speed (n), feed rate (f), point angle and lubricant. In order to minimize the values of all the above-mentioned performance characteristics, an optional combination of input drilling parameter is required. Taguchi optimization technique is used to for optimization drilling parameters is required: ANOVA is used to find the highly influential drilling parameter(s) that contributes to a highly quality product.

2. Experimental Procedure

A vertical type of Vertical Machining Centre (VMC) was used in this study. Magnesium is metal who is lightweight (1.74g/cm3), 1.6 times lighter than al and 4.5 times lighter than steel. The toughness of broken is greater and mightier than ceramic biomaterial and elasticity module is 45 GPa which has at near elasticity module of human bone [10]. Magnesium - aluminium alloy has been used as biomaterial, for example AZ31 (Mg-3Al-1Zn), contains of Zn as additional material [11]. The specimens hold in VMC machine and cut into dimension of 40 x 50 x100 mm. First full drilled with twist drill 5 mm diameter and the depth of 40 mm for pre drill with 405 rpm and feeding 0.1 mm/rev. in order to get straight path while drilling of diameter 12 mm. A drill of 12 mm diameter with parameter and different level, inserted so that drilling process happened into each specimen holes measurement and follow the rule of Taguchi L18.

The surface roughness every hole must be checked by CMM or with USB microscope so that roughness grades each surface will be known. Cylindricity and perpendicular surface of every holes checked by CMM so that the roundness or the perpendicular will be known. Surface roughness each hole has to be examined with CMM or USB microscope, and the rate of holes roundness and its perpendicular can be determined too. In general, the surface roughness value resulting in range 0.33 until 1.99 μm. The highest surface roughness value 1.99 μm obtained in the drilling process in 405 rpm, feeding 0.1 mm/rev, point angle 450 and synthetic oil lubricant. The highest surface roughness value is 1.99 µm obtained in drilling process happened in rotation 405 rpm, feeding 0.1 mm/rev, point angle 450 and synthetic oil lubricant. While the lowest surface roughness value obtained in 0.33 µm happened in rotation 890 rev/men, feeding 0.2 mm, point angle 650 and synthetic oil lubricant.

The holes cylindricity value produced be range of 0.017 mm to 1.122 mm. The value of cylindricity has the highest poverty rate 0,017 mm where is obtain on drilling process n = 405 rev/men, feeding of 0.3 mm/rev and point angle of 450 with lubricant of crude palm oil. While the lowest value of cylindricity obtained in 1,122 mm in drilling process at spindle speed of 405 rpm, feeding of 0.3 mm/rev and point angle of 550 with soybean oil lubricant. The value of perpendicular is in (run no 14) that was between rotation 890 rpm, feeding of 0.2 mm/rev, point angle of 550 and lubricant with soybean oil. While the farthest deviation to the process is number 2 where happened in rotation of 405 rpm, feeding of 0.1 mm/rev, point angle of 550 and lubricant is palm oil.

3. Results and Discussions

3.1. Surface roughness value of drilling process
In principle the surface roughness objects work on the machine not uniform throughout the machining process because affected by the state of cut as, the rate cuts, depth of cut in cutting and types of cutting tool.

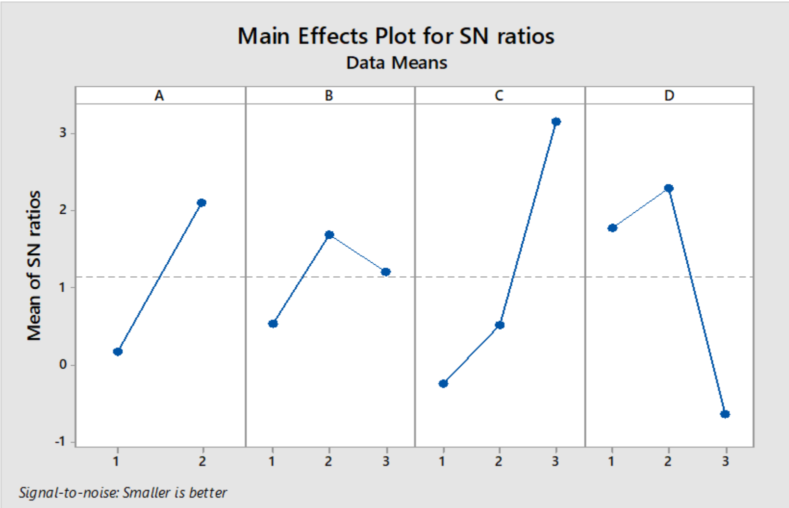

Figure 1. SNR Chart plot for the priority factors of surface roughness (Ra) for Magnesium AZ31.

Figure 1 that point angle (delta 3.4023, rank=1) has leverage greatest in SN Ratio, followed by a lubricant (delta 2.9504, rank 2) followed by round and feeding. The value of the roughness. The surface roughness value not only influenced by a feeding factor and spindle speed. It's also influenced by the tool nose radius factor [12]. Based on formula Ra = f / Re, so the greater the tool nose radius, the surface roughness will be reduced. But a rough surface is because the edge wears contours uneven/smooth. Mechanically there are parameters that can affect Ra namely feeding (f) and nose radius (Re), if f increased and Re move down there will be increasing Ra.

3.2. Cylindricity value of the drilling operation
One of the constituents of a change in roundness value would be happened if the length of left cutting edge and right cutting edge are not the same. On the lowest roundness value obtained to the process with the test number 8 with the 1.122 mm in drilling process with spindle speed of (n) 405 rpm, feeding of 0.3 mm/rev and point angle of 550 and the lubricant is soya oil. As shown in Figure 2 that a

drill bit for test number 8, on its cutting edge, one side on the size 12.95 mm and another side is 13.25 mm happened the difference between long body so that these at the time spun and cut will cause tangential force who not in equipoise so that a circle being oval do not a circle geometrically. The difference between cutting force resulting to an insistent wall a hole in line with a style of cut into the larger [13]. The point angle (delta 3.4023, rank=1) has greatest leverage in SN ratio, followed by a lubricant (2.9504, rank=2) followed by spindle rotation and feeding, as shown in Figure 3.

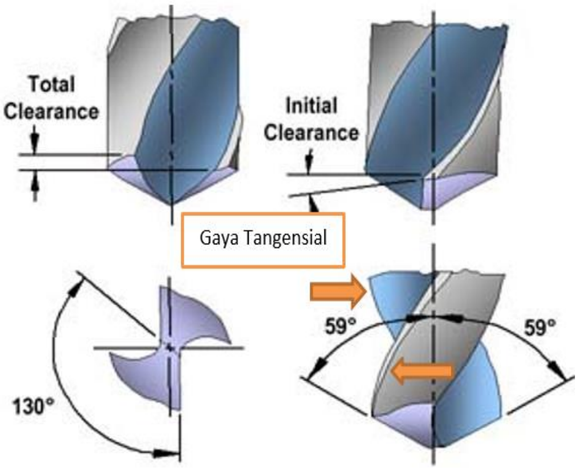

Figure 2. Tangential force on drill bit

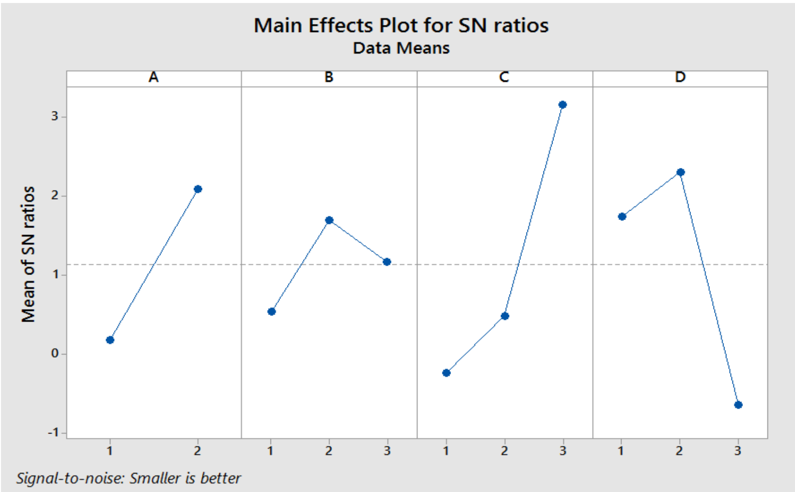

Figure 3. The plot SNR ratio to the cylindrical main factor

3.3. Perpendicularity of the drilling operation

The result of optimizing the ratio SN ANOVA found a significant parameter against fixed variable of perpendicular seen of the value of P-value < α (0.05) used in research. In this case feeding 1 with p = 0.044, and interaction between (feeding * lubricant) with P=0.041 which is smaller than α (0.05) showed the significance. This showed that feeding 0.1 mm/rev to the drill machining process of magnesium AZ31 use a twist drill diameter 12 mm influence on the result perpendicular value from drilling process, especially if there is the interaction of the feeding of 0.1 mm/rev and synthetic lubrication. Viscosity influence at the speed of a liquid filling contact between machine tool and a work piece and a liquid thin of them [14]. Hopefully with a feeding of 0.1 mm/rev (smallest one) with synthetic lubricant and with high viscosity caused more stability of cutting holes wall that led to good perpendicularity value as shown in Figure 4.

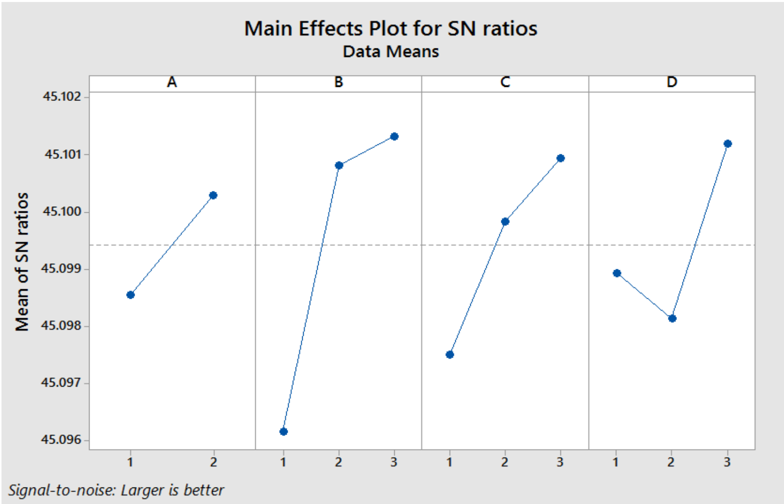

Figure 4. The plot SNR ratio to the perpendicularity main

Feeding (delta 0.01, rank=1) have greatest leverage in the SN Ratio, followed by point angle (delta 0.00, rank=2) are followed by lubricant and spindle speed. If we use feeding 1, lubricant 1 associated with the highest mean strength. The result of two directions ANOVA shows that interaction between feeding and lubricant is significant. Perpendicular deal with the machine tool structure with tool geometric (length and helical corner)

4. Conclusions

The research results show that surface roughness of machined surface affected by contribution of point angle of 18.9% and lubricant of 14.5%, where the point angle is 650 with the synthetic oil lubricant. The emergence of a tendency nose radius resulting in increasing subtlety level. Roundness influenced by point angle 450 of drilling process, especially if there is an interaction to feeding 0.2 mm/rev and synthetic lubricant. The accuracy of cutting edge led to tangential force so that had an impact on Cylindricity their rotation stability and cylindricity drilling result. The perpendicular value of magnesium AZ31 is strongly influenced by cutting parameter of feeding that produces significance p=0.044, while strongest significance happened if there were interaction between feeding 0.1 mm/rev and synthetic lubricant in p=0.0041. The less feeding of the process with a high viscosity of synthetic lubricant cause more stable of hole wall cutting and led to good value of perpendicular

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