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Investigation on Aluminium Alloy 11 Using Taguchi Design Methodology on CNC Milling

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Abstract: Orthogonal Taguchi Matrix is considered with three destructive levels of machening parameter, tests are performed using Orthogonal Group L9 (34) with nine columns, and nine unique by mixing nine specific parameters. Tests were processed and each estimate was collected. Work After heavy machening, each part of the material determines its surface roughness. The estimated surface/noise ratio (S/N) is close to the ideal quality of the test. The goal of the work is done by estimating the signal-to-noise ratio of the assertion. The test was within the expected limits.

Keywords: Keywords: Aluminium, Milling, Surface Roughness Taguchi Method.

1. Introduction:

Taguchi has developed a method for applying the design of testing, together with a manual for the students. This methodology takes the design of experiments from the exclusive world of statisticians and brings it more fully into the world of production [28]. His contribution also facilitates the work of experts by advocating the use of experimental design and understanding the nature and economic impact of quality engineering changes in manufacturing. Taguchi presents the following approach using experimental design.

1. Design and develop products/processes that are suitable for environmental condition;
2. Design and develop products/processes that are adapted to component fluctuations;
3. Decrease volatility around target values.

This Taguchi philosophy is widely applicable. He suggested that process or product engineering optimization should be done using a three-step move towards: system design, parametric design, and tolerance design. Related to the design stage, material, component selection, expected value of product parameters, etc.Since the design of the system is the first step, the functional design may be far from optimal in terms of quality and cost. The goal of Parametric This design aims to optimize the tuning of process parameter values to improve performance characteristics and identify suboptimal values for product parameters. Therefore, parametric design is an important step in Taguchi methods to achieve high quality. To solve this problem, Taguchi's method uses a special orthogonal lattice design to explore the entire parameter space in just a few experiments to determine the loss function between the experimental and desired values.Use the loss function to measure operating characteristics that deviate from the desired value. The value of the decay function is converted to a signal to noise ratio (S / N). In general, for signal-to-noise analysis, lowest to highest, highest to highest and highest rate. The signal-to-noise ratio for each process parameter level is calculated based on the S / N analysis. The highest signal-to-noise ratio corresponds to the best performance characteristics, regardless of the type of signal characteristic. Therefore, the optimal level of the process parameters is higher in the S / N and ANOVA analysis, and the optimal combination of the process parameters can be predicted. Finally, run validation tests to confirm the optimal process parameters.. The parameters obtained from the Taguchi method of process parameters are applied to achieve most favourable dispensation performance in the sinking procedure.

- Larger is good (maximum) : S/NLB. = -1 log ((1/n) Σ (1/yi ²))
- Smaller is good (minimum) : S/NSB .= -1 log ((1/n) Σ yi ²)

Where n is the numbers of examinations or iterations of the experiment and y is the detected data. Note that these signal-to-noise ratios are conveyed on a decibel scales. Use S / NT if the goal is to diminish variability around the intention, use S / NL if the system is optimized when the reaction is as large as feasible, and when the reaction is as large as potential. Use S / N'S but your system is optimized for Possible. The bigger the possible answer. The smallest possible. The appropriate level of S / N optimization factor is optimal. Optimizing a process using the Taguchi method parametric design has many performance characteristics, including the following steps:

- ✓ Pick the suitable orthogonal network and map the procedure constraints to the orthogonal network.
- ✓ Carry out research based on the preparation of orthogonal matrices.
- ✓ Obtain the investigational results using signal-to-noise ratio and ANOVA.
- ✓ Choose the optimum level of method parameters.
- ✓ Verification of most favourable method parameters by verification test

2. Experimental Setup

In present investigation, the experiments are conducted on a Vertical Milling macheni of model BFW Agni +BMV 45 + tc24 manufactured by BFW. The macheni specifications are shown in the table 1 below. Milling is the second most used macheni after lathe macheni. The material is removed in form of chips from the work-piece by the facilitate of rotary cutter tool rotating at high velocity. The macheni was accessible at Central Institute of Plastic Engineering and Technology, Lucknow. Figure 1 on the next page shows the BFW Agni +BMV 45 + tc24.

Table 1: Materials properties of AL-1100

(Cu) Copper.	0.04-0.25%
(Fe) Iron.	0.96Max
Manganese.	0.04%
(Si).Silicon.	0.94%
(Zn).Zinc.	0.12%
Density (x100 kg/m2).	2.80
Residual.	0.16%
Poisson's Ratio(µ)	0.34
Elastic Modulus (E) (GPa).	68-80
Tensile Strengths (Mpa).	112
Yield Strengths (Mpa).	106

Table 2: CNC milling mchine

Height/Stroke Length	450. mm
Length of the bed	600. mm
Clamps use	Hydraulic vice
coolant	Diesel Engine Oil

Table 3: Tool details

Materials	Carbide.
Diameter	55.0mm.

Table 4: Surface roughness Equipment details

Tip Material	Diamond
Traverse length of tip	8mm

3. Surface Roughness:

Surface roughness indicates the quality of the machening or work. When the plane roughness of the work is reduced, the surface finish of the work is improved and the machening quality is improved, so it is desirable to reduce the surface roughness of the work. Plane roughness is measured with a Mitutoyo 178602 plane roughness meter. The figure below is a Mitutoyo 178602 plane roughness meter and the specifications for plane roughness adjustment. Surface quality plays an impotant role in the performance of machenid surfaces. A good quality floor plane improves fatigue resistance, corrosion resistance and service life. plane roughness also affects many functional properties of parts, such as wear resistance, surface friction, lubricant distribution and retention, and coating retention. The irregularities caused by the cutting action of the cutting edge and the abrasive grains and the advancement of the macheni tool due to the machening and action of the abrasive grains are called plane roughness, called texture irregularity, and the roughness is considered to overlap fundamentally be finished On wavy surfaces. The upper limit of height or the roughness form created by a single point cutting tool is given by

$$\mathbf{Hmax = f^2 / 8R}$$

Where f is feed and R is nose radius.

Fig. 1: BFW Agni+BMV 45 + tc24

Fig. 2: MITUTOYO 178-602 Surface Roughness tester measuring the roughness of surface machined by milling machine

Roughness is an impotant parameter in determining whether a plane is suitable for a particular use. Rough planes frequently wear out faster than smooth surfaces. Rough planes are often susceptible to corrosion and cracking, although they also contribute to adhesion. Roughness meters are used to rapidly and precisely find out the plane texture or plane roughness of a material. The roughness meter displays the determined roughness depth (Rz) and the average roughness value (Ra) in micrometers or micrometers (µm).To measure surface roughness; you need to apply a roughness filter. Different international standards and specifications for texture or plane finish recommend the use of different roughness filters. Example, the ISO standard habitually recommends a Gaussian filter.

4. Result and Discussion:

Surface roughness is a calculation of the relative smoothness of a plane profile. In this case, numeric parameters are used. The Ra surface texture graph shows the arithmetic mean of the surface height. As already mentioned, the surface has three basic components. These include roughness, the waviness, and the lay. Therefore, several factors influence the shape characteristics of the surface.

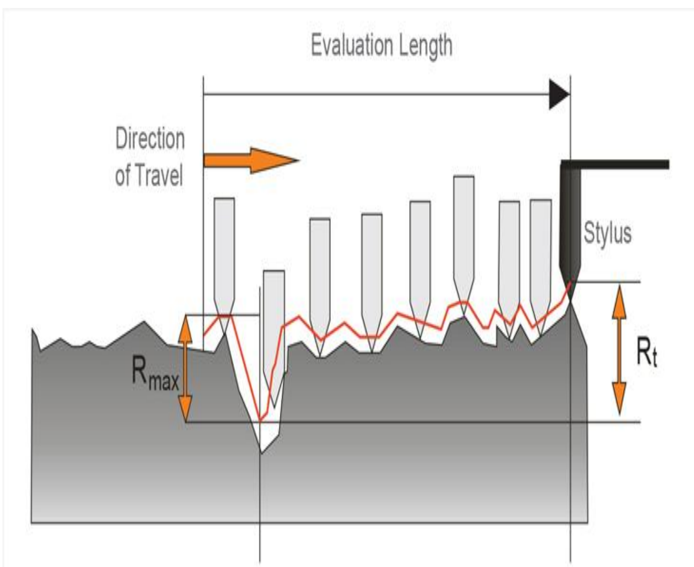

Fig. 3: Different factors are affecting the characteristics of surface geometry.

1. Direct measuring methods.
2. Non Contact method,
3. Comparison method,
4. In-process method,

The direct measurement method uses a pencil to measure the roughness of the surface, so the pencil should be drawn perpendicular to the surface. The machinist then uses the saved profile to determine the roughness parameters. White light and confocal light replace the pencil.These instruments use different measuring principles. The physical probe can be modified with an optical sensor or a microscope. First, the apparatus is used to send an ultrasonic pulse to the surface. Then there are the changes and reflections of the sound waves. You can then evaluate the reflected wave to determine the roughness parameters. On the other hand, the comparison method uses a surface texture pattern. These patterns are generated by the device or process. The manufacturer then uses visual and tactile sensations to compare the results. The results are compared with known surface roughness parameters. Current engineering is inductance.This method is useful for evaluating surface roughness with magnetic materials. Here, the inductive receiver uses electromagnetic energy and uses the energy to measure the distance to the surface. The defined parameter values will help you find comparative roughness parameters.

Table 5: Calculations for surface roughness

Iterations Numbers	Control Factors				Surface roughness
	Spindle's Speed(rpm)	Feed's rate (mm/min)	Depth of Cut(mm)	Coolant's Flow(Lt/min)	
1	1500	1200	0.50	80	0.61650
2	1500	840	1.00	100	0.60300
3	1500	600	1.50	120	0.41750
4	2500	1200	1.00	120	0.67550
5	2500	840	1.50	80	0.41500
6	2500	600	0.50	100	0.38900
7	3500	1200	1.50	100	0.38150
8	3500	840	0.50	120	0.45200
9	3500	600	1.00	80	0.41500

The chart shows the relationship among the plane roughness and the four parameters of a CNC milling machine. Feed rate has a great influence on surface roughness and is the most influential parameter with a contribution rate of 32.23%. It is the most dominant factor for plane roughness. Plane roughness seems to increase as the feed rate boosts. This is because increasing feed reduces vertical removal time, generates heat in the tool and workpiece, and removes material more quickly. As a result, the surface roughness of aluminem 110 increases at forward speed. The minimum observed surface roughness is 60 mm / min. Spindle speed is the second dominant factor for surface roughness with a contribution of 24.When the spindle speed increases to 45%, the heat from the friction causes the tool and components to heat up. Even at high speed, the material removal rate is high and the material is removed from the surface in the form of chips.

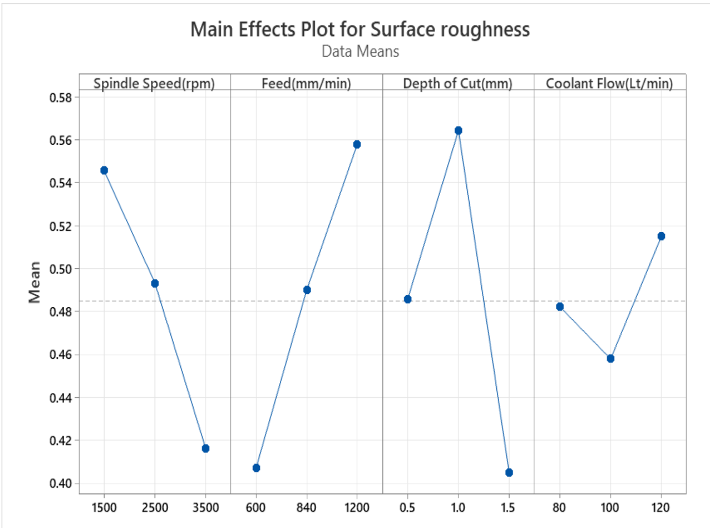

Fig. 4: Main effect plot for means of surface roughness

High heat rates and large craters increase the roughness of the surface. Minimum surface roughness was observed at 150 rpm.As can be seen, depth of cut is the third factor that determines plane roughness with a involvement rate of 9.61%. Coolant flow was found to be the smallest surface roughness modifier with a involvement of 1.57%. His influence is negligible compared to that of. Feed speed and cutting speed. There was no significant change in the surface roughness value as the refrigerant flow rate increased.

5. Conclusion:

The present experimental investigation was conducted on **BFW Agni+BMV 45 + tc24** vertical milling macheni using Aluminium alloy 110 as work piece and HSS as tool to analyze the consequence of process constraints viz. feed rate, spindle's speed, depth of cut and coolant's flow on performance measures plane roughness. The subsequent conclusions were made on the base of investigation is Feed's rate has a great impact on plane roughness and is the most influencing parameter with an involvement of 32.23 %. It dominates plane roughness significantly. The plane roughness appears to get increase with the increase in the level of feed rate. This is as when the feed is boost, the time for the length material to be removed diminishes. Surface roughness is minimum at 600mm/min and maximum at 1200mm/min.Due to the induced heat in tool and the work piece and faster material removal, the surface roughness of Aluminium alloy 110 increases with feed rate.

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