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Experimental investigation and analysis of process parameters for face milling operation

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Abstract

In this paper, Taguchi method has been used to identify the optimum condition of input parameters in the milling process .In the present study optimization of surface roughness and material removal rete (MRR) using Taguchi method is doing for end milling operation. Milling experiment has been performed on Aluminium LM25 material, according to Taguchi orthogonal array [L9] for the different combination of input parameters which are spindle speed, feed rate, depth of cut (DOC) .Signal to noise ratio is applied to measure the performance characteristics deviating from the actual value .Analysis Of Variance (ANOVA) is used to identify the variables affecting the MRR, surface roughness, machining time, temperature.

Keywords: Aluminium LM25 material, Milling machine, Taguchi methodology, S/N ratio , ANOVA

INTRODUCTION

The machining industries are facing a great challenge to achieve high quality, good surface finish and high material removal rate with a view to economize in machining. End Milling is widely used in a variety of manufacturing industries including the aerospace and automotive sectors, where quality is an important factor in the production of slots, pockets, precision molds, and dies because good-quality milled surface significantly improves fatigue strength, corrosion resistance, and creep life. In end milling operations, material removal rate (MRR) determines the economics of machining and rate of production. In setting the machining parameters, the main goal is to increase MRR.

The manufacturing process like machining, casting, grinding, forging, molding and welding are used to produce the products of which customer need is satisfied. Milling is the process in which the metal removal rate and surface finish is high. During milling process, a rotary cutter is used which are in direct contact with the material. One of the important advantage of milling process is that it is suitable for mass production and having high dimensional accuracy and surface finish process. The significant factors normally considered for the experimental investigations are spindle speed, feed rate, depth of cut and dimensions of the test specimen. During milling, high amount of heat is produced at the interface of tool and work piece. The quality of machining depends on the proper selection of materials and process cutting parameters. The main objective of this experimental investigation is to showcase the Surface Roughness on the milling of Aluminium LM25 material.

The present experiment the optimization speed obtained using taguchi technique is 2487rpm , Similarly the result obtained for feed and depth of cut are 1540 mm/min , 1.5mm/min .The optimum coolant flow is 4.8 litres /min , The S/N ratio value of verification test is within limits predicted value and objective of work is full filled [1]

It consist of two method taguchi , regression , analysis ,choice of operation condition , cutting speed parameter , feed rate parameter , engagement parameter , To minimize the surface roughness and maximum the material removal rate in two methods [2]

This experiment were carried under three stages, First stage – experimental work , were carried out using taguchi method . The various spindle speed, feed and depth of cut was investigated, Second stage – the effect of control factor on response was determined by analysis of variance, Third stage – this response was optimized by MINITAB [3]

The work was carried by various milling parameter such as doc , feed and speed for the better of surface roughness, AISI304S.S plate material, M/C ; vertical milling machine using carbide insert, By analyzing the mean and annova table the significance of each machining parameter on surface roughness [4]

Study of vegetable based cutting fluid using of milling factor (cutting speed , doc , feed rate), D-optimal method is conducted to develop mathematical model for process responses (specific energy , surface roughness , tool life) can be predicted effectively with quadratic model, Result of optimization various conclusion are drawn about effect of the milling parameter and the cutting fluid type on the milling performance [5]

The optimal from S/N ratio of machining for low surface roughness obtained is 2500 rpm 240 mm/min and 2.0 from spindle speed , feed , doc, Also confirmation test by using annova shown that feed rate has more contribution 46.36 %,spindle speed has moderate contribution 34.78 % and depth of cut has less contribution [6]

The experiments were conducted on three different cutting speed (80 m/min , 100 m/min, 120 m/min) with three different feed rates (0.1 ,0.2 , 0.3 mm/rev) at constant depth of cut 0.5 mm, The cutting parameters are optimized using S/N ratio and analysis of variance, This were done to analyze the surface roughness , flank wear and MRR, Feed rate is significant parameter for roughness where cutting speed is parameter for influencing MRR and flank wear [7]

Investigation of thread milling parameter ; tread geometry , cutting condition , tool angle , these are applied to tool optimization, The cutting force and torque were measured and represented values of its variation calculated and analyzed response to experiment, The understanding of geometrical and mechanical aspect in thread milling [8]

Annova analysis result show the optimal combination for low resultant cutting force and good surface finish are high cutting speed , low feed rate and low depth of cut, Using taguchi method of DOE among milling parameter are also investigated, Generally use of high cutting speed slow feed and low depth of cut leads to better surface finish and low cutting force [9]

For brass – cutting speed 600 m/min , feed 1000 m/min doc 0.4 mm, For aluminium – cutting speed 1800 m/min , doc 0.2 m , feed 1000 m/min .The optimized surface roughness value of 6463 aluminium alloy is 1.69 and brass is 0.70 µm. in the analysis surface roughness decreases , increase cutting speed , feed , doc. [10]

In this experimental investigation was observed the machining performance with various cutting speed feed and depth of cut using side and face milling cutter, Roughness were found by employing taguchi design of experiments and annova, Relevant machining parameters were identified by using signals to noise ratio [11]

The various parameter such as feed , doc , speed used to fit the experimental values, By analysis the value , we can determine the significant factor affecting the surface roughness [12]

The main parameter affects the surface roughness, MRR , maching time have been identified analyzed under different condition and finally optimized, The taguchi method it gives maximized normalized combined S/N ratio of tangent output, The obtain optimization machining parameter to achieve better surface finish characteristic during milling , better MRR during turning and better optimization machining time during turning [13]

The study included feed rate spindle speed and depth of cut as control force and noise factor were the operating chamber temperature and the use of different tool in the same application, Annova analyses were carried out to identify significant factor affecting surface roughness and the optimal cutting combination was determined by detecting the best surface roughness and signal to noise ratio, Finally confirmation test verified that the taguchi design was successful in optimizing milling parameter for surface roughness [13]

This paper presents the mechanics of turn-milling operations to predict cutting forces, torque and power requirements. Typical turn milling process involves three linear (*x, y. z*) and two rotary drives of the machine tool. The resulting feed vector is modeled as a function of linear velocities of the drives, and angular speeds of work piece and tool spindles. The generalized chip thickness distribution is modeled as a function of linear feed drive motions, tool and work piece spindle rotations. The cutting force predictions are experimentally verified for sample cylindrical and ball end mills. The identification of productive tool and work piece spindle speeds is demonstrated using chip load limit of the tools and torque-power constraints of the turn milling machine tools. [15]

Surface analysis technique includes surface defects, multiple liner regression analysis. Surface parameter and auto correct analysis of the surface. The experimental results have feed marks, scratches adhered material particle. High quality of the machined surface can obtained in the combined condition with high cutting speed, low feed and small radial doc. Auto correlation analysis is used to describe the speed relation dependence of the surface topography, It increasing the feed rate has the opposite effect [16]

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