IJRAME
ISSN (ONLINE): 2321-3051
INTERNATIONAL JOURNAL OF RESEARCH IN
AERONAUTICAL AND MECHANICAL ENGINEERING

A Review on Optimization of cutting parameter for Surface Roughness, Material Removal rate and Machining Time of Aluminium LM-26 Alloy

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Abstract

In this paper a comprehensive review about various parameters and the production cost of a product. Various parameters affect the manufacturing as well as production cost of a product. It is very important to select optimum parameters for minimum machining costs and maximum machining effectiveness, when metal cutting machine tools are employed. Various parameter like cutting speed, depth of cut and feed require proper setting of various parameter during machining. Production cost of a product can be reduced by using the proper tools and parameters, like machine tools, cutting tools material, tool geometry and cutting parameters. The overall paper gives an idea about how to produce high quality products at relatively low cost and also provides optimization of cutting parameter for surface roughness, material removal rate and machining time of Aluminium Alloy LM-26.

***Keywords*:** Parameters; tool geometry; machine tools; cutting tools material; Aluminium Alloy LM-26.

1. Introduction

In industrialized countries, the value of manufactured products contains 20% the cost of machining and hence it is important or imperative to investigate the machine ability behavior of different materials to obtain optimal results, by changing the machining parameters . The machine ability can be calculated or obtained by an optimal combination of factors like a minimum cutting force, best surface finish, low temperature of tool tip , and lastly the power consumption must be low. All these factors effects on the costing of the products. Process modeling and optimization are the two important issues in manufacturing products. The selection of optimal cutting parameters is a very important issue for every machining process. The cutting parameters are depth of cut, feed and speed.

The physical and metallurgical requirements of a good cutting tool material include; High yield strength at cutting temperature, fracture toughness, wear resistance, fatigue resistance, thermal capacity and thermal conductivity, thermal shock resistance, and low solubility in the work-piece material. Now a day‘s many manufacturing industries used optimization of parameters of production processes.

2. Aluminium LM-26 Alloy

The main properties which make Aluminium a valuable material are is lightweight, strength, recyclability, corrosion resistance, durability, ductility, form ability and conductivity. These properties make it unique and due to these properties the variety of applications of Aluminium continues to increase. Aluminium alloys are classified under two classes; cast alloys and wrought alloys. Furthermore, they can be classified according to the specification of the alloying elements involved. The main differences between these two alloys are; wrought Aluminium alloys have excellent machine-ability, while cast alloys containing copper, magnesium or zinc as the main alloying elements can cause some machining difficulties. Most of the alloys having Silicon as the main alloying element, and hence requires larger tool rake angles, lower speeds and feeds. This parameters makes them more cost effective to machine.

Aluminium LM-26 alloy is mainly used in pistons of petrol and diesel engines. And, to urgently machine this alloy, by taking into consideration the optimized parameters, we can within no time manufacture the components made up of this alloy. Hence we can save time, labor, and money and machine hours while producing parts made up of this Aluminium alloy. Contents of Aluminium LM-26 alloy is; Copper (2-4%), Magnesium (0.5-1.5%), Silicon (8.5-10.5%), Iron (1.2% max), Manganese (0.5% max), Nickel (1% max), Zinc (1% max), Lead (0.2% max), Tin (0.1% max), Titanium 0.2% max), and Aluminium (Remainder).

3. Literature Review

Optimization of parameters is usually a difficult work to develop realistic constrains. For the proper parameter it required the knowledge of specification of machine tool capabilities and knowledge of mathematical as well as numerical optimization techniques and also effective optimization criterion. The selection of appropriate machining parameters is difficult and relies heavily on the operators' experience and the machining parameters provided by the machine-tool builder for the target material. Hence, the optimization of operating parameters is of great importance where the economy and quality of a machined part play a key role.

Surasit Rawangwong, Jaknarin Chatthong, Worapong Boonchouytan, and Romadorn Burapa in [1]. In this paper they explain a use of Carbide Tool for Optimum Cutting Conditions in Face Milling Aluminium Semi Solid 2024. The research in this paper could be applied in the manufacture of automotive components and mold industries. For the experimental result they used computer numerical controlled milling machine with 63 millimeter diameters fine type carbide tool with twin cutting edge. They work on three controlled factors that is the speed, the feed rate and the depth of cut. The depth of cut was not more than the 1 mm. They used factorial designs for the experiment and the result of this experiment showed that the factors feed rate was affected on the surface roughness and the speed while the depth of cut did not affect with the surface roughness. In this experiment, when the speed was 3,600 rpm and the feed rates were 1,000 mm/min, the surface roughness was reduced. The linear equation in this research was

$$Ra = 0.205 - 0.000022\ Speed + 0.000031\ Feed\ rate$$

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The equation formula was used with face mill cutting tool; with the speed in the range of 2,400 - 3,600 rpm, feed rate in the range of 1,000 - 1,500 mm/min and the depth of cut not over 1 mm. the research results shows that, the mean absolute percentage error (MAPE) of the surface roughness was obtained 3.48 %., this MAPE was less than the specified error and it was acceptable.

T. Wang, L.J. Xie, X.B. Wang, L. Jiao, J.W. Shen, H. Xu, and F.M. Nie in [2]. In this paper, they explain different parameter for Surface integrity of high speed milling of Al/SiC/65p Aluminium matrix composites. Experimental work focused on high speed milling of high fraction volume Al/SiC/65p. They considered three main milling parameters i. e. milling speed, feed rate and axial depth of cut for the experiment. And understand the effects of these parameters on the machined surface integrity, including surface roughness, residual stress and morphology. The surface quality of components was damaged by the particle reinforced Aluminium matrix composites (PRAMCs). PRAMC is one of the most important factors which reduced practical performance of the components. In this paper, they present a systematic experimental research of high speed milling of Al/SiC/65p by polycrystalline diamond tools. For the experimental result they used cutting parameters such as surface roughness (Ra), surface residual stress (RS) and morphology of PRAMC. Also to analyze the influence of the present reinforcements on surface integrity; the experiments on corresponding unreinforced matrix alloy Al 6063 were also carried out.

The most significant milling parameter for surface roughness was milling speed then the feed rate, followed by the interaction between feed rate and milling speed. The experimental result demonstrated that , while the effect of milling speed was negligible, surface roughness improved slightly with the decrease in the feed rate. Residual stress measured in feed direction by X-ray diffraction (XRD) indicated that the conditions of machined Al6063 surface were all tensile, while the conditions of Al/SiC/65p were compressive [2].From the experiment they conclude that; milling speed has the highest influence on Ra, The surface roughness of Al/SiC/65p increases gradually with the rise of the feed rate, the surface residual stress of both Al6063 and Al/SiC/65p increase tensile stress with the increase of the feed rate.

Moaz H. Ali, Basim A. Khidhir, M.N.M. Ansari, and Bashir Mohamed in [3]. In this paper they described, Finite element modeling to predict the effect of feed rate on surface roughness with cutting force during face milling of titanium alloy under dry cutting conditions. Firstly, FEM is a dominant technique, which is used in structural mechanics and it belongs to the numerical simulation methods. Hence Finite element modeling (FEM) is considered a famous method. In this paper they focused on three parameters, feed rate (f), surface roughness (Ra) and cutting force components (Fc, Ft). They observe the readings of these three parameters, during the face-milling operation of the titanium alloy Ti–6Al–4V. In experimental approach, they kept the axial depth of the cut and cutting speed remains constant in dry cutting conditions and used several feed rates (f). Finally they found that, Finite element modeling can lead to reduced machining time and manufacturing cost as well, because of accuracy of both values of the cutting force for the experimental and predicted model was about 97%.

Anjan Kumar Kakati, M. Chandrasekaran, and Amitava Mandal in [4], “Prediction of Optimum Cutting Parameters to obtain Desired Surface in Finish Pass end Milling of Aluminium Alloy with Carbide Tool using Artificial Neural Network”. In this work an experimental investigation of end milling of Aluminium alloy with carbide tool is carried out and the effect of different cutting parameters on the response is studied with three-dimensional surface plots. An artificial neural network (ANN) is used to establish the relationship between the surface roughness and the input cutting parameters (i.e., spindle speed, feed, and depth of cut).

Dr. M. Naga Phani Sastry, K. Devaki Devi, and Dr. K. Madhava Reddy in [5], they explain Machining Process Parameters Using Design of Experiments. Machining process involves many process parameters such as feed, speed, depth of cut. They are directly or indirectly affect the surface roughness and also affects metal removal rate of the product. They gives best model by using the result of three effects i.e. main effects is nothing bur independent parameters, quadratic effects is nothing but the square of the independent variables, and third one is interaction effects of the variables. After taking 20 readings in a single set, they used DESIGN EXPERT-8 Software. DESIGN EXPERT-8 Software helpful for improvement plan of the Manufacturing process & Techniques, and it has been used to reduce the manipulation.

R. Ramanujam, R. Raju, and N. Muthukrishnan in [6], they described a new methodology for the optimization of the machining parameters on turning Al-15%SiCp metal matrix composites. By using desirability function analysis, they optimize the parameter of machining and also they used Taguchi's L27 orthogonal array. Narayana B. Doddapattar and Chetana S. Batakurki in [7] deals with experimental investigations to optimize mach-inability of commercial Al – 7050 (Aluminium) and also to obtain optimum process parameters. By using Taguchi's Method they explain that how three parameter such as speeds, depth of cuts, feed rates and nose radius will affect mach-ability. Taguchi's orthogonal array based on DOE was used to explain the important techniques, such as for optimization of process parameters of CNC and the L9 orthogonal array has been used to conduct the experiment for the material considered in this study.

4. Conclusion

Aluminium LM-26 alloy is mainly used in pistons of petrol and diesel engines. Various parameters affect the manufacturing as well as production cost and these parameters has been discussed and reported in this paper. The work done in this field is reviewed in literature review.

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February 2014.
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