iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3074

Optimization of Machining Parameter in Milling Operation using Taguchi Technique

Irfan Khan[1], Dr. Ajoy Kumar[2]
[1, 2] Department of Mechanical Engineering, Dwarkadas J. Sanghvi College of Engineering, Mumbai University, Vile Parle West, Mumbai–400056, Maharashtra, India.

Abstract: Metal cutting is one of the most significant manufacturing processes in the area of material removal. Black defined metal cutting as the removal of metal chips from a work piece in order to obtain a finished product with desired attributes of size, shape, and surface roughness. The main objective of industries are producing better quality product at minimum cost and increase productivity. In this study, optimum cutting parameters of Inconel 718 are determined to enable minimum surface roughness under the constraints of roughness and material removal rate. A series of experiments will be done by varying the milling parameters spindle speed, coolant rate, feed rate and depth of cut. . The process parameters are optimized for better surface finish using Taguchi technique in Minitab software.
Keywords: Milling, nickel alloy inconel 718, carbide tool, taguchi's design methodology, cutting parameters, surface roughness.

I. INTRODUCTION

Inconel 718, a nickel-based super alloy, is widely used in air craft, nuclear industries, submarines, steam power plants, petrochemical equipment's, chemical industries and medical applications [1] because of good tensile, fatigue, and creep life properties. However properties such as ability to react with tool materials under atmospheric conditions, formation of built-up edge, weld to the cutting edges and presence of abrasive carbides in their microstructure causes poor machinability of these materials and restrict the wider usage [2].

They are known to be among the most difficult-to-cut materials. Several researchers have studied the effect of cutting conditions in machining of nickel based super alloys [3]. Most of the research on machining Inconel alloy is concentrated mainly on the study of cutting tool and wear mechanism. Poor selection of

tool and wear mechanism. Poor selection of machining parameters causes cutting tools to

wear and break quickly as well as economical losses such as damaged work-piece and poor surface quality [4]. Surface roughness in machined surfaces is observed upon milling this material. Surface roughness on Inconel 718, as for other materials, is also contributed by tool geometry and material properties, cutting kinematics and cutting conditions [5]. Measurement of surface roughness is used to determine surface quality of machined surfaces. .

Every manufacturing industry is trying to achieve the high quality products in a very short period with less input. In milling machine, there are many process parameters like spindle speed, feed rate, depth of cut, coolant, tool geometry, etc. which affected on required quality parameters. So, selections of such process parameters are important for any quality parameters.

II. LITERATURE SURVEY

The experimental research conducted by Drazen Bajic [6] examines the influence of three cutting parameters on surface roughness, tool wear and cutting force components in milling as part of the off-line process control. The experiments were carried out in order to define a model for process planning. Cutting speed, feed per tooth and depth of cut were taken as influential factors.

The experimental research conducted by K. Adarsh Kumar [7] Surface finish is one of the prime requirements of customers for machined parts. The objective was to establish correlation between cutting speed, feed rate and depth of cut and optimize the turning conditions based on surface roughness. The purpose of this research paper is focused on the analysis of optimum cutting conditions to get lowest surface roughness in milling by regression.

The experimental research conducted by H. K. Dave[8] , presents the machining characteristics of different grades of EN materials in milling process using Tin coated cutting tools.

The experimental research conducted by B. Sidda Reddy [9], presents minimization of surface roughness has been investigated by integrating design of experiment method, Response surface methodology (RSM) and genetic algorithm.

III. MATERIAL & METHODS

A. Milling Machine

Milling is a cutting process that uses a milling cutter to remove material from the surface of a work piece. The milling cutter is a rotary cutting tool, often with multiple cutting points. As opposed to drilling, where the tool is advanced along its rotation axis, the cutter in milling is usually moved perpendicular to its axis so that cutting occurs on the circumference of the cutter. As the milling cutter enters the workpiece, the cutting edges (flutes or teeth) of the tool repeatedly cut into and exit from the material, shaving off chips (swarf) from the workpiece with each pass. The cutting action is shear deformation; material is pushed off the workpiece in tiny clumps that hang together to a greater or lesser extent (depending on the material) to form chips. This makes metal cutting somewhat different (in its mechanics) from slicing softer materials with a blade. The milling process removes material by performing many separate, small cuts. This is accomplished by using a cutter with many teeth, spinning the cutter at high speed, or advancing the material through the cutter slowly; most often it is some combination of these three approaches.[10] The speeds and feeds used are varied to suit a combination of variables. The speed at which the piece advances through the cutter is called feed rate, or just feed; it is most often measured in length of material per full revolution of the cutter. There are two major classes of milling process In face milling, the cutting action occurs primarily at the end corners of the milling cutter. Face milling is used to cut flat surfaces (faces) into the work piece, or to cut flat-bottomed cavities. In peripheral milling, the cutting action occurs primarily along the circumference of the cutter, so that the cross section of the milled surface ends up receiving the shape of the cutter. In this case the blades of the cutter can be seen as scooping out material from the work piece. Peripheral milling is well suited to the cutting of deep slots, threads, and gear teeth.

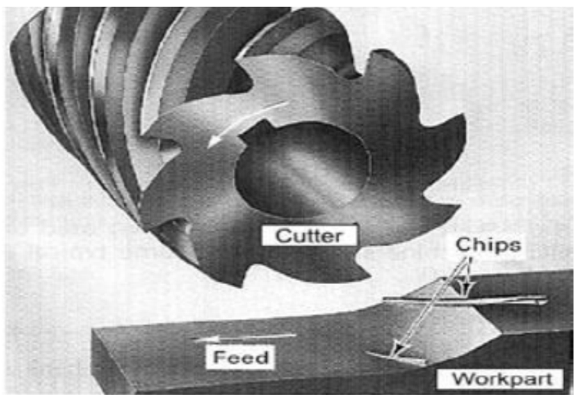


Fig. 1: Basic Milling Operation

B. Surface Roughness

Surface finish is an essential requirement in determining the surface quality of a product. It is one of the crucial performance parameters that have to be controlled within suitable limits for a particular process. Therefore, monitoring of the surface roughness of machined components has been an important area of research. Surface roughness is difficult to attain and track than physical dimensions are, because relatively many factors affect surface roughness.

C. Taguchi Method

Taguchi method is a powerful tool for the design of high quality systems. It provides simple, efficient and systematic approach to optimize designs for performance, quality and cost [11]. Taguchi method is used where the quality is improved at the design stage instead of controlling it at the manufacturing stage. A customer usually considers several correlated quality characteristics of a product. Metal cutting is widely used manufacturing process in the industries. The metal cutting studies focus on features of tools and machine parameters which affects the process and output quality characteristics. High speed machining technologies and use of modern machine tools enables the improvement of surface roughness by accurate displacement of tool and good surface finish of the machined surface. The desired cutting parameters are determined based on experience or by hand book. Cutting parameters are reflected on surface roughness, surface texture and dimensional deviation turned product [12].the correct selection of cutting parameters such as feed rate, depth of cut, cutting speed etc. generates optimum conditions during machining and becomes the main exigency of manufacturing industry. The philosophy of Taguchi is broadly applicable. He proposed that engineering optimization of a process or product should be carried out in a three-step approach, i.e., system design, parameter design, and tolerance design.

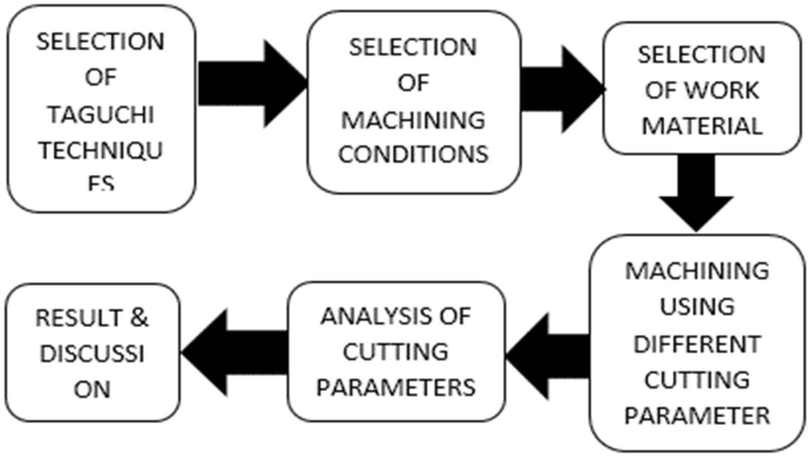


Fig. 2 Flow Chart of Taguchi Method

In system design, the engineer applies scientific and engineering knowledge to produce a basic functional prototype design, this design including the product design stage and the process design stage. In the product design stage, the selection of materials, components, tentative product parameter values, etc., are involved. In process design stage, the analysis of processing sequences, the selections of production equipment, tentative process parameter values, etc., are involved. Since system design is an initial functional design, it may be far from optimum in terms of quality and cost The objective of the parameter design [13] is to optimize the settings of the process parameter values for improving performance characteristics and to identify the product parameter values under the optimal process parameter values Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only.A loss function is then defined to calculate the deviation between the experimental value and the desired value. Taguchi recommends the use of the loss function to measure the performance characteristic deviating from the desired value. The value of the loss function is further transformed into a signal-to-noise (S/N) ratio h. There are three categories of the performance characteristic in the analysis of the S/N ratio, that is, the lower-the-better, the

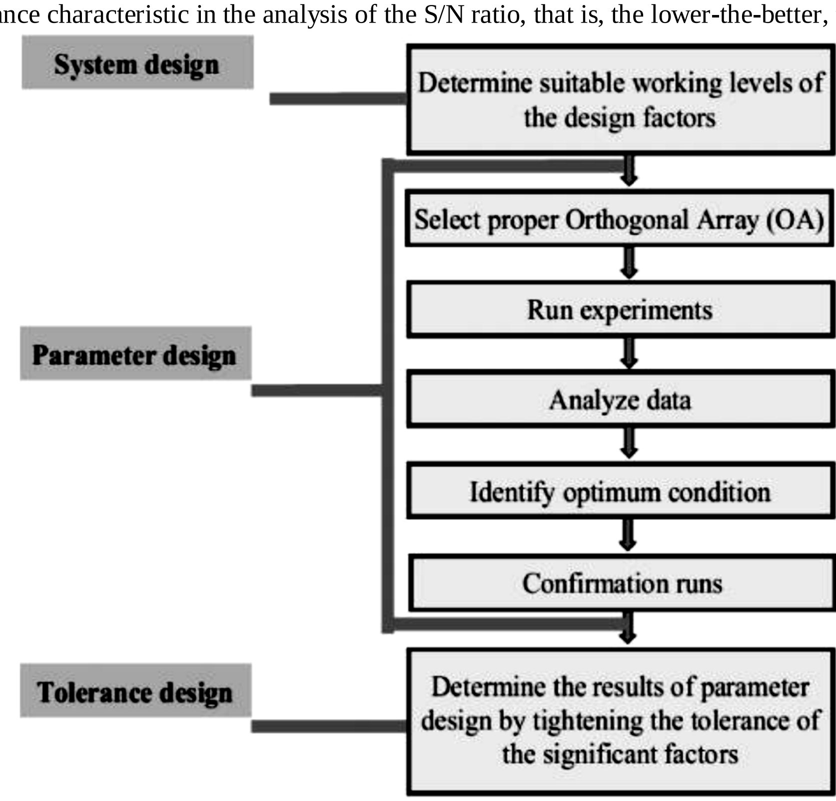


Fig. 3: Taguchi Design Procedure

Higher-the-better, and the nominal-the-better. The S/N ratio for each level of process parameters is computed based on the S/N analysis. Regardless of the category of the performance characteristic, the larger S/N ratio corresponds to the better performance characteristic. Therefore, the optimal level of the process parameters is the level with the highest S/N ratio ρ Furthermore, a statistical analysis of variance (ANOVA) is performed to see which process parameters are statistically significant. With the S/N and ANOVA analyses, the optimal combination of the process parameters can be predicted. Finally, a confirmation experiment is conducted to verify the optimal process parameters obtained from the parameter design. In this paper, the cutting parameter design by the Taguchi method is adopted to obtain optimal machining performance in Milling.

1) Nominal is the better: S/NT = 10 log $(\frac{Y}{S_y 2})$……………..(1)
2) Larger-is-the better (maximize): S/NL = - 10 log $(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_i 2})$……(2)
3) Smaller-is-the better (minimize): S/NS = - 10 log $(\frac{1}{n}\sum_{i=1}^{n} y_i 2)$…….(3)

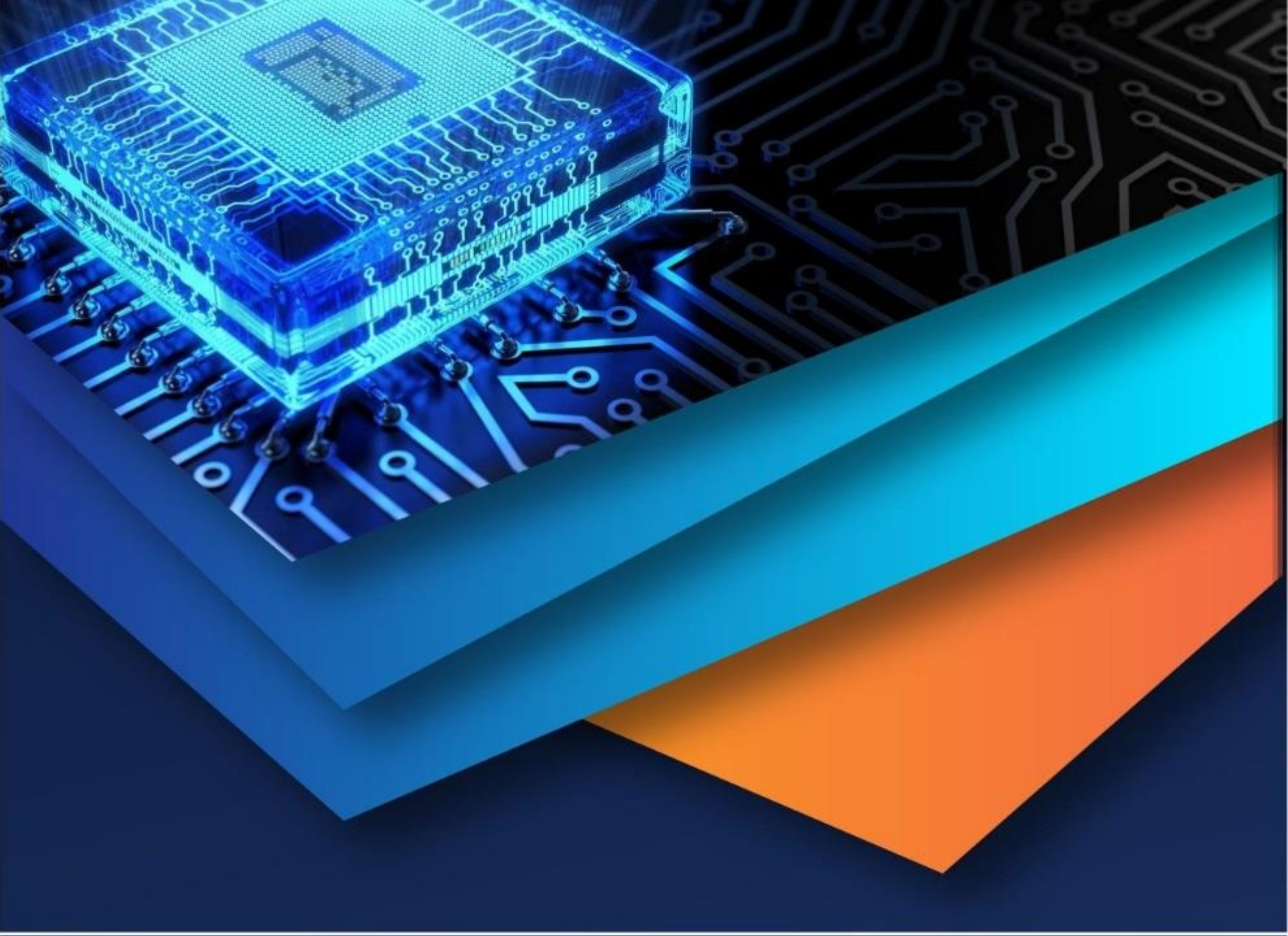
Where y is the average of observed data, $S_y 2$ is the variance of y, n is the number of observations and y is the observed data. Notice that these S/N ratios are expressed on a decibel scale. We would use S/NT if the objective is to reduce variability around a specific target, S/NL if the system is optimized when the response is as large as possible, and S/NS if the system is optimized when the response is as small as possible. Factor levels that maximize the appropriate S/N ratio are optimal. The goal of this research was to produce minimum surface roughness (Ra) in a milling operation. Smaller Ra values represent better or improved surface roughness. Therefore, a smaller-the-better quality characteristic will be implemented and introduced in this study.

IV. CONCLUSION

Taguchi method has been adopted for the design of experiments and results have been by minimizing S/N ratio. Optimization of the surface roughness was done using Taguchi method and Predictive equation was obtained. Experiments have been performed in order to investigate the effects of one or more factors of the process parameters (spindle speed, feed rate and depth of cut) on the surface finish of the machined surface. The investigation is based on surface roughness during milling of Nickel alloy Inconel 718. Parameter design of the Taguchi method provides a simple systematic and efficient methodology for the optimization of the cutting parameters.

REFERENCES

[1] Krain H., Sharman A., Ridgway K., 2007, Optimisation of tool life and productivity when end milling Inconel 718TM, Journal of Materials Processing Technology, 189: 153 61
[2] J.S.Senthilkumaar, Selvarani, R. M. Arunachalam, 2012. Intelligent optimization and selection of machining parameters in finish turning and facing of Inconel 718, International Journal of Advanced manufacturing and technology, 58, p.885.
[3] D. Dudzinski, A. Devillez, A. Moufki, D. Larrouque`re, V. Zerrouki, J. Vigneau, 2004. A review of developments towards dry and high speed machining of Inconel 718 alloy, International Journal of Machine Tools & Manufacture, 44, p. 439.
[4] Dudzinski D., 2004, A review of developments towards dry and high speed machining of Inconel 718 alloy, International Journal of Machine Tools and Manufacture, 44: 439-56.
[5] Leshock C.E., Kim J.N., 2001, Plasma enhanced machining of Inconel 718: modeling of workpiece temperature with plasma heating and experimental results, International Journal of Machine Tools and Manufacture, 41: 877-97.
[6] Modeling of the Influence of Cutting Parameters on the Surface Roughness, Tool Wear and Cutting Force in Face Milling in Off-Line Process Control by DraženBajić, Luka Celent,Sonja Jozić, University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, Croatia
[7] Optimization of surface roughness in face turning operation in machining of EN by K. Adarsh Kumar, Ch.Ratnam, BSNMurthy, B.Satish Ben, K. Raghu Ram Mohan Redd
[8] Effect of machining conditions on MRR and surface roughness during milling of different Materials Using TiN Coated Cutting Tools – A Taguchi approach by H. K. Dave, L. S. Patel, H. K. Raval
[9] Optimization of surface roughness in milling using response surface methodology and genetic algorithm by B. Sidda Reddy, J. Suresh Kumar, and K. Vijaya Kumar Redd
[10] Kramer, Thomas R. (1992). "Pocket Milling with Tool Engagement Detection". Journal of Manufacturing Systems. 11 (2): 112–123. doi:10.1016/0278-6125(92)90042-E. Retrieved 11 March 2015
[11] W.H. Yang, Y.S. Tang, Design optimization of cutting parameters for milling operations based on Taguchi method, Journal of Materials Processing Technology, 84 (1998) 122-129.
[12] N. Nalbant, H. Gokkaya, G. Sur, Application of Taguchi method in the optimization of cutting parameters for surface roughness in turning, Materials and Design, date received 21.07.2006 and date accepted 06.01.2006
[13] Montgomery, D.C., 1997, Design and analysis of experiments. 4th ed. New York: Wiley.



10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY