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Optimization of Machining Parameters In A Turning Operation of Austenitic Stainless Steel To Minimize Surface Roughness And Tool Wear : A Review

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ABSTRACT

The current study used a TiAlN coated carbide insert tool to turn on austenitic stainless steel of grade AISI 202. The primary purpose of the following research was to use Response Surface Methodology to evaluate the impact of machining parameters such cutting speed, feed rate, and depth of cut on the surface roughness of the machined material and tool wear. The turning operation is a fundamental metal machining process that is frequently employed in metal cutting industries. The selection of machining parameters for a turning operation is a critical step in achieving good performance.

This paper presents review of literature related to utilization of current trends in industries.

Keywords : TiAlN, CCD, Talysurf, ANOVA, review, advancement, industrial development.

I. INTRODUCTION

The turning operation is a fundamental metal machining process that is frequently employed in metal cutting industries [1]. The selection of machining parameters for a turning operation is a critical step in achieving good performance [2]. We define high performance as good machinability, better surface finish, lower tool wear, higher material removal rate, faster rate of production, and so on.

A product's surface finish is typically quantified in terms of a metric known as surface roughness. It is regarded as a product quality indicator [3]. Enhanced surface polish can result in improved strength qualities such as corrosion resistance, temperature resistance, and longer fatigue life of the machined surface [4,5]. Surface finish, in addition to strength attributes, can affect the functional behaviour of machined components, such as friction, light reflective properties, heat transmission, ability to distribute and hold a lubricant, and so on [6,7]. Surface finish has an impact on production costs as well [3]. For the aforementioned reasons, minimising surface roughness is critical, which can be accomplished by optimising some of the cutting settings.

Tool wear is a natural occurrence in all classic cutting operations. Researchers attempt to eliminate or reduce tool wear since it affects both product quality and production costs. Extensive investigations on tool wear characteristics must be undertaken in order to improve tool life [8]. Machining parameters such as cutting speed, feed, depth of cut, and so on, as well as tool material and its properties, work material and its properties, and tool geometry, are all factors that influence tool wear and surface roughness. Minor adjustments in the aforementioned criteria can have a considerable impact on product quality and tool life [3].

II. LITERATURE SURVEY

Alagarsamy, S. V. et al., (2020) Using the Taguchi technique, the machining parameters of brass C26130 alloy are optimised during the CNC end milling process. The testing results reveal that the combination of 750 rpm spindle speed, 20 mm/rev feed rate, and 1 mm depth of cut is the best for minimum surface roughness (SR), and the combination of 750 rpm spindle speed, 60 mm/rev feed rate, and 0.75 mm depth of cut is the best for least tool wear (TW). The ANOVA findings suggested that the spindle speed and feed rate were the most influential parameters on SR and TW.

Bhushan, Rajesh Kumar (2020) Green production necessitates minimising waste. The production of fewer chips has a less negative impact on the environment. The nose radius plays a significant influence in chip development. The right nose radius and machining settings will limit the amount of chip and so safeguard the environment. Abrasion was discovered to be the primary cause of tungsten carbide insert wear while turning AA7075/15 wt. percent SiC (20 - 40 m) composites. This study is unique in that no one has previously explored the impact of nose radius and machining parameters on surface roughness, tool wear, and tool life during turning of AA7075/15 wt. percent SiC composites. The findings of this study will be beneficial to the automobile, aeroplane, space, and ship industries.

Yildirim et al., (2020) Although nickel-based aerospace superalloys such as alloy 625 have exceptional qualities such as high tensile and fatigue strength, corrosion resistance, and good weldability, among others, its machinability is a difficult issue that can be overcome by using alternate cooling/lubrication strategies. When turning alloy 625, a medium cutting speed (75m/min) is recommended for the lowest roughness value and lowest peak-to-valley height. Furthermore, as compared to cryogenic machining, MQL and CryoMQL reduce tool wear by 50.67% and 79.60%, respectively. An intriguing finding is that MQL reduces cutting tool wear more effectively than cryogenic machining.

Ramesh, S. et al., (2016) Because of its attractive qualities, magnesium alloy (Mg alloy) is one of the lightest materials and has a wide range of uses in the production of aircraft engines, airframes, helicopter components, light vehicles, automobile parts, and computer systems. ANOVA is used to demonstrate the adequacy of the proposed mathematical model. The investigation's findings revealed that feed rate and cutting speed are the most important parameters for surface roughness and tool flank wear, respectively.

Akıncıoglu et al., (2016) The Taguchi method was used in this work to assess the effect of cryogenically treated tools in turning Hastelloy C22 super alloy on surface roughness. Using the Taguchi experimental design method, the optimum turning parameters (cryogenic treatment, cutting speed, and feed rate) were identified. The validation tests revealed that the Taguchi approach can greatly improve surface roughness. Shallow cryogenic treatment (CT1) and deep cryogenic treatment (CT2) applied to cementite carbide tools decreased surface roughness by 28.3 and 72.3 percent, respectively (UT). It was discovered that shallow and deep cryogenic treatments increased the wear resistance of tungsten carbide inserts.

Acayaba, Gabriel Medrado Assis et al., (2015) Surface roughness is an important production quality since it affects the product's tribological, frictional, and assembly qualities. Turning stainless steel at low cutting speeds can result in a rougher surface due to built-up edges, while increasing speed reduces surface roughness by allowing bonding to occur due to the short contact time between the chip and the tool. In order to develop a set of cutting parameters with minimal surface roughness, the constructed Artificial Neural Network model was paired with an optimisation process known as Simulated Annealing (SA). The SA algorithm successfully generates a low surface roughness value and the associated set of parameters.

Nayak, Shreemoy Kumar et al., (2014) The current study intends to investigate the effect of various machining parameters such as cutting speed (Vc), feed rate (f), and depth of cut (t) on various performance metrics during dry turning of AISI 304 austenitic stainless steel. For the current application, ISO P30 grade uncoated cemented carbide inserts were employed as a cutting tool. An attempt was also made to optimise the machining parameters at the same time using grey relational analysis. Based on the researched performance criteria (i.e. MRR, Fc, and Ra), the optimum parametric combination was Vc =45m/min, f=0.1mm/rev, t=1.25mm. A confirmatory test was also performed to validate the results, and an improvement in grey relational grade (GRG) of 88.78 percent was noted.

Naves, V. T.G. et al., (2013) The goal of this work is to investigate how cutting fluid supplied at high pressure and at varied concentrations influences tool wear processes in the turning operation of AISI 316 austenitic stainless steel utilising coated cemented carbide tools. The experiments were carried out in a turning operation, with different pressures (10, 15, and 20 MPa) applied between the chip and tool at the rake face. The outcomes are compared to both dry and wet cutting. The chemical vapour deposition at medium temperature (MTCVD) approach was used to coat cemented carbide tools of class ISO K with TiN, Al_2O_3, and Ti (C,N). The least amount of wear was obtained when the fluid was administered at a concentration of 10% and a pressure of 10MPa.

Fernández-Abia et al., (2013) The analysis was created by doing wear tests and analysing several signals such as cutting forces, insert EDX analysis, component roughness, and insert image analysis. According to the results, the best coatings for turning difficult-to-machine materials such as austenitic stainless steels are nACo® and AlTiN coatings since they provide the best performance. Several considerations support this claim, including improved tool flank wear evolution, decreased tangential cutting force, and lower part roughness.

Saini, Sanjeev et al., (2012) Response surface methodology (RSM) is used in this study to model surface roughness and tool wear in finish hard turning under a variety of cutting conditions. Experiments on hardened AISI H-11 steel finish turning were used to generate the experimental data. Surface quality was significantly improved by lowering the feed rate and increasing the cutting speed. Increasing the cutting speed, on the other hand, resulted in a significant increase in tool wear. In addition, tool wear and surface roughness were unaffected by the depth of cut.

Çaydaş, Ulaş and Ekici, Sami (2012) To evaluate the surface roughness values of AISI 304 austenitic stainless steel in CNC turning operations, three distinct types of support vector machines (SVMs) tools were developed, including least square SVM (LS-SVM), Spider SVM, and SVM-KM, as well as an artificial neural network (ANN) model. In the building of predictive models, turning elements such as cutting speed, feed rate, and depth of cut were included as model variables. For this objective, a three-level complete factorial design of experiments (DOE) method was used to acquire surface roughness values. A multilayered design made up of 15 hidden neurons positioned between the input and output layers made up a backpropagation-based feedforward neural network. All of the SVMs used outperformed the ANN in terms of prediction, with excellent correlations between the predicted and empirically observed values.

Seeman, M. et al., (2010) Metal matrix composites (MMC) have emerged as a leading material among composite materials, with particle reinforced aluminium MMCs garnering particular attention due to their superior technical features. Because of the hardness and abrasive character of the reinforcing element-like silicon carbide particles, these materials are classified as difficult-to-machine materials (SiCp). In this study, an attempt was made to simulate the machinability evaluation using response surface methodology in the machining of homogenised 20% SiCp LM25 Al MMC produced using stir cast route. On the basis of two performance criteria, flank wear (VBmax) and surface roughness, the combined impacts of four machining parameters, including cutting speed (s), feed rate (f), depth of cut (d), and machining time (t), were analysed (Ra). The contour plots were made to look into the impact of process variables and how they interact. The response surface methodology of the desirability-based approach is used to optimise the process parameters.

Kaladhar, M. et al., (2010) The goal of this paper is to explore how to use CVD coated cemented carbide tools to optimise machining parameters when turning AISI 202 austenitic stainless steel. Process variables such as speed, feed, depth of cut, and nose radius are used in the experiment to see how they affect the surface roughness of the work piece (Ra). The experiments were carried out on a CNC lathe using a full factorial design in the Design of Experiments (DOE). In addition, the analysis of variance (ANOVA) was used to look at the impact of process variables and how they interacted during machining. The feed has the largest influence on surface roughness, followed by nose radius, according to the findings of the study. There has been an attempt to develop surface roughness prediction models. Validation trials are used to make sure that the expected values are correct.

Li, Kuan Ming and Chou, Shih Yen (2009) Micro-milling is an appropriate technique for producing microstructures with high aspect ratios and complicated geometries. The use of the micro-milling method to cut hardened tool steel is extremely difficult. Based on experimental measurements of tool wears and surface finish, this study compares the mechanical performance of MQL to fully dry conditions for micro-milling of SKD 61 steel. MQL has also been shown to have an influence on burr formation. The results show that using MQL reduces tool wear, improves surface roughness, and reduces burr development.

Dhar, N. R. et al., (2006) Tool wear is a natural occurrence in all machining processes, and ultimately leads to tool failure. The increasing demand for high machining productivity necessitates the utilisation of high cutting velocity and feed rate. This type of machining generates high cutting temperatures, which not only affects tool life but also degrades product quality. The goal of this paper is to describe the findings of an experiment that looked at the impact of MQL on tool wear and surface roughness when turning AISI-4340 steel at an industrial speed-feed combination with an uncoated carbide insert. MQL's promising results include a significant reduction in tool wear rate and surface roughness, owing to a lower cutting zone temperature and a favourable shift in chip-tool and work-tool interaction.

Özel, Tuğrul and Karpat, Yiğit (2005) Surface quality is one of the most important client requirements in part machining. Surface roughness is a major indicator of surface quality on machined objects. Finish hard turning with Cubic Boron Nitride (CBN) tools enables manufacturers to streamline their processes while maintaining the necessary surface roughness. For various cutting situations, trained neural network models were utilised to predict surface roughness and tool flank wear. Increased workpiece hardness resulted in improved surface roughness but increased tool wear. Overall, CBN inserts with honed edge geometry outperformed CBN inserts without honed edge geometry in terms of surface roughness and tool wear development.

III. CONCLUSION

In this paper we observed that authors in recent researches analysed and studied various method to minimize roughness and provide wear conditions of tools.

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