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Short Communication

IMPROVE THE QUALITY OF MACHINING PRODUCT BY HYBRID METHOD

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Abstract: The present work studies the performance of multi-layer coated tool in machining of hardened steel (AISI 4340 steel) under high speed turning. The influence of cutting parameters (speed, feed, and depth of cut) on cutting forces and surface finish has been analyzed. Under the different cutting conditions, forces were measured using dynamometer. Cutting force and SR are mostly affected by speed and feed. Taguchi quality loss function was adopted to optimize the turning process with multiple performance characteristics.

Key Words: AISI 4340 steel, Taguchi quality loss function, surface finish, Cutting force.

Introduction

The majority of cutting tools in use today employ chemical vapour deposition (CVD) or physical vapor deposition (PVD) hard coatings. The high hardness, wear resistance and chemical stability of these coatings offer proven benefits in terms of tool life and machining performance. The first technique is the CVD. This method deposits thin films on the cutting tools through various chemical reactions. Most tool coatings were traditionally deposited using the CVD technique until the recent development of PVD. This method deposits thin films on the cutting tools through physical techniques, mainly sputtering and evaporation.Coated hardmetals have brought about tremendous increase in productivity since their introduction. Since then coatings have also been applied to high speed steel and especially to HSS drills. Coatings are diffusion barriers,they prevent the interaction between chip formed during the machining and the cutting material itself. The compounds which make up the coatings used are extremely hard and so they are very abrasion resistant. Typical constituents of coating are Titanium Carbide(TiC), Titanium Nitride (TiN), Titanium Carbonitride (TiCN) and alumina (Al2O3).All these compounds have low solubility in iron and they enable inserts to cut two le at much higher rate than is or multi-layer.

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Challenges in Metal Cutting

Because of the highly nonlinear nature of metal cutting and the complex coupling between deformation and temperature fields, a complete understanding of the mechanics of metal cutting is still lacking and is thus the topic of great deal of current research.High speed machining has been the main objective of the Mechanical Engineering through ages. The trend to increase productivity has been the instrumental in invention of newer and newer cutting tools with respect to material and designs. High speed machining is not associated with increased productivity and better surface finish rather associated with a great amount of heat generation. Also the power requirement rises since amount of cutting force is involved. The range of materials which one can use for cutting has been in a continuous state of development .Any machining operation which involves the removal of metal by a cutting action requires that the material used for cutting will stand up to the rigours of that cutting action. The main properties which any cutting material must possess in order to carry out its function are:

1. Hardness to overcome wearing action
2. Hot strength to overcome the heat involved
3. Sufficient toughness to withstand vibration

The achivement of high quality, in terms of workpiece dimensional accuracy, surface finish, high production rate, less wear on the cutting tools, economy of machining in terms of cost saving and increase the performance of the product with reduced enviornmental impact are the main and effective challenges of modern metal cutting and machining industries [1,2,3]. Traditionally, hardened steels are machined by grinding process due to their high strength and wear resistance properties but grinding operations are time consuming and limited to the range of geometries to be produced. In recent years, machining the hardened steel in turning which uses a single point cutting tool has replaced grinding to some extent for such application. This leads to reduced the number of setup changes, product cost and ideal time without compromising on surface quality to maintain the competiveness [4,5]. The improve technological process, proper tool selection, determination of optimum machining parameters (cutting speed, feed, depth of cut) or tool geometry (nose radius, rake angle, edge geometry, etc.) are necessary in order to obtain the desired surface finish comparable to grinding [6,7].

Tugrul O zel et al [7] presented the effects of cutting edge preparation geometry, work-piece surface hardness and cutting conditions on the surface roughness and cutting forces in the finish hard turning of AISI H13 steel. They have found that the cutting forces are influenced not only by cutting conditions but also the cutting edge geometry and work-piece surface hardness. The lower workpiece surface hardness and small edge radius resulted in lower tangential and radial forces.Jeong Suk Kim et al [8] investigated that hard coatings improve the performance of cutting tools in aggressive machining applications, such as high-speed machining. Additionally, the relationship between the machining characteristics and the Si contents were investigated under various high-spindle speeds. It has shown that the tool life was improved up to 50% at the Si content. J.G. Lima et al [9] have evaluated the machinability of hardened steels at different levels of hardness and using a range of cutting tool materials. They have proved in their result that turning of AISI 4340 steel using low feed rates and depths of cut, the forces were higher when machining the softer steel and that surface roughness of the machined part was improved as cutting speed was elevated and deteriorated with feed rate.

Objective of Work

From the available literature, it can be seen that though some work has been reported on influence of turning parameters on surface roughness and cutting forces measurement of the machined surface, no attempt has so far been made to systematically to optimize the process variables with a view to obtain favorable responses. Moreover, cutting forces cannot be characterized as a single response since it typically includes cutting force on turning process. Therefore, there should be research endeavor to apply multi-objective optimization techniques in order to achieve reasonably low value of SR and high value of cutting forces.

Materials and Method

In this case Taguchi's loss function and fuzzy will make hybrid to improve the quality of specimen. Metal cutting process forms the basis of the engineering industry and is involved either directly or indirectly in the manufacture of nearly every product of our modern civilization. The cutting tool is one of the important elements in realizing the full potential out of any metal cutting operation. Over the years the demands of economic competition have motivated a lot of research in the field of metal cutting leading to the evolution of new tool materials of remarkable performance and vast potential for an impressive increase in productivity. As manufacturers continually seek and apply new manufacturing materials that are lighter and stronger and therefore more fuel efficient it follows that cutting tools must be so developed that can machine new materials at the highest possible productivity. The properties that a tool material must process are as follows:

- Capacity to retain form stability at elevated temperatures during high cutting speeds.
- Cost and ease of fabrication
- High resistance to brittle fracture
- Resistance to diffusion
- Resistance to thermal and mechanical shock

Developmental activities in the area of cutting tool materials are guided by the knowledge of the extreme conditions of stress and temperature produced at the tool-work piece interface. Tool wear occurs by one or more complex mechanisms which includes abrasive wear, chipping at the cutting edge, thermal cracking etc.

The cutting tools must be made of materials capable of withstanding

- High stresses (High strength and wear resistant)
- High temperature (high hot hardness)
- Shock generated during chip formation (tough)

In addition to this the material should have the following properties. Chemical stability,Anti welding and anti-diffusivity, Thermal conductivity, Low thermal expansion coefficient, High Young's modulus, Easy availability ,manufacturability and above all low cost.

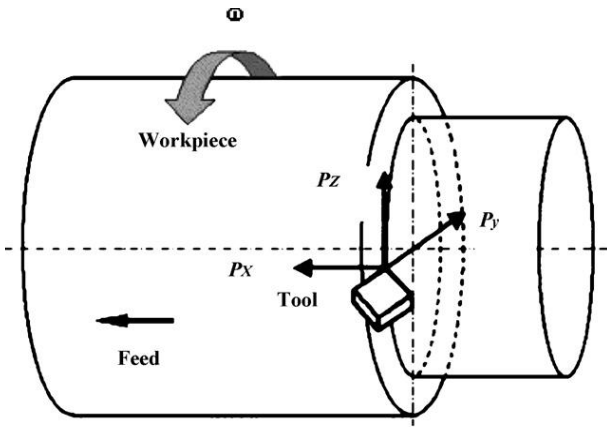

Fig. 4.1 Cutting-force components [5]

The forces acting on a tool are an important aspect of machining for studying the machinability conditions. Knowledge of the cutting forces is needed to estimate the power requirements and ensure that the machine tool elements, tool-holders, and fixtures are adequately rigid and free from vibrations. Measurements of the tool forces are helpful in optimizing the tool design. This is shown in Fig. 4.1.

The cutting forces were measured with a piezoelectric 3-Component Dynamometer (Kistler-9257B) mounted on the lathe. The charge signal generated at the dynamometer was amplified using charge amplifiers (Kistler Type 5814B1) that are shown in Fig. 4.2.

Quartz 3-Component Dynamometer(type - 9257B)Manufactured by – KistlerInstrumente AG, CH-8408 Winterthur, Switzerland
Calibrated partial range for Fx&Fy = 0-500 N, for Fz = 0-1000 N

Fig. 4.2 Kistler piezoelectric dynamometer

Machine specification of Multichannel Charge Amplifier:--

Manufactured by – KistlerInstrumente AG, CH-8408 Winterthur, SwitzerlandType 5070A having 8 nos. of channel

Result and Discussion

Forces were measured and recorded for the different cutting conditions both for coated and uncoated tools. The three force components are, the main cutting force (Fz), thrust force (Fx) and radial force (Fy).The measuring signal output was recorded by the N.I. (National Instrument) LAB VIEW data acquisition system (NI 9234) with RS-232C interface between amplifier and the PC allowing all settings and queries to be made in the instrument. Since the analogue signals received from the dynamometer were low, the amplifiers were needed. Three amplifiers were used to amplify analogue signals received from three channels; and supply voltage, input/output signals and deviation values for the desired measurement range were adjusted. These signals (which were the cutting force signals) were converted into digital format in a data acquisition card and were input to the PC.

Conclusions

The three components of forces, i.e., the main cutting force (*Fz*), feed force (*Fx*) and radial force (*Fy*) generated by TiN coated carbide tools for all cutting speeds indicating that turning with former tools is more economical than the latter in terms of energy and power requirements. This study included that TiN carbide tool produce better surface roughness with respect to high speed and low feed rate.But the depth of cut has minor effect on surface roughness.

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