COMPARISON ON 1037 CARBON, T-42 H.S.S, CHROME STEEL AND TUNGSTEN CARBIDE USED AS SINGLE POINT CUTTING TOOL LITERATURE REVIEW

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ABSTRACT

Our main aim is the comparison of different material like 1037 Carbon, T-42 H.S.S, Chrome Steel and Tungsten Carbide which are used as single point cutting tool for different Depth of Cut. Modelling of single point cutting tool is done by using design software CATIA V5 R20. The model is then imported in ANSYS 14 software and meshing is done. Then at different depths of cut, the readings of stress were calculated and input to the software. The CATIA 14 software analysed the model by using finite element analysis and produced the stress readings for different depths of cut. The equivalent stresses developed at the tip of the tool, Maximum principal stress and also shear stresses are determined. Finite element analysis of single point cutting gave the result that a maximum stress is generated at the tip of the tool it is the one of the major cause of failure.

One of the best cutting tools is required to achieve maximum advantage in producing a good quality product. Our work is aimed at finding the best cutting tool among the most commonly used tools which are used in lathe machines for various operations. The various tools material that we have used is 1037 Carbon, T-42 H.S.S, Chrome Steel and Tungsten Carbide. Selection of suitable material for a cutting tool and its geometry is important for getting desirable MRR, rate of production, rigidity of the setup, machined surface, accuracy, surface finish etc. Although selection of a tool material doesn’t have a fixed rule but the economy, budget and demand of specific cutting tool property decides the type of material to be selected.

1. INTRODUCTION

The process of manufacturing work piece by removing undesirable material from a block of metal as chips is called Machining or Metal cutting. This method is most significant since the majority of the product get their final form and size by metal removal, either directly or indirectly [2]. Machining can be defined as the process of removing undesirable material from the work piece in the form of continuous and discontinuous chips. Turning operation is nothing but rotation of work piece against the tool in machine. Chip is formed due to the shear force acting on the cutting tool [4]. By direct application of force, a physical object or its portion can be separated into two parts. If a sharp object is supplied with a sufficiently larger force, it can cut a material provided it has hardness more than the object which is to be cut. Single point cutting tool as the name suggests removes the material using only one edge for cutting purpose and is used in various operation such as shaping, planning, turning and similar operations. Tools employed in Milling and Drilling operation uses multiple edges for cutting purpose and so they are called multipoint cutting tools. The factors which are most important during the cutting operation are various clearance angle of the cutting face, speed and feed at which the tool is run [1].

1.1 TYPES OF CUTTING TOOL

There are two types of cutting tool:

- Single point cutting tool
- Multi point cutting tool

1.1.1 Single Point Cutting Tool

Tools which have only single or one cutting edge is called single point cutting tool. A single point cutting tool consists of a sharpened part which is the actual cutting part and is called as its cutting point and the other part is called shank. The various operations for which these tools are used are turning, shaping, boring and planning operations. These single point cutting tool are used on lathe machines,planer,shaper, boring machines etc. [17].

1.1.1.1 Geometry of single point cutting tool

Tool geometry is defined as the basic tool angles, i.e. various relief and clearance angles given on single point cutting tool to make it highly efficient in cutting. A single point tool has been used most extensively in the industries and they have only one cutting edge. Single point cutting tool is designed with sharp edges to minimize rubbing contact between tool and work-piece. Factors like cutting tool life, surface finish of the work piece, force required to shear the work piece for formation of chip are substantially affected by variations in shape of cutting tool [17].

2. LITERATURE REVIEW

The purpose of this chapter is to provide a review the efforts put in the past by the various researchers in the field relatedmachining operation by single point cutting tool and its finite element analysis. The reviews of some other relevant research are also provided. The review is done with the purpose of providing an insight to how past research efforts have laid the groundwork for future studies, including the current research effort. The review is given in detail so that the present effort can be properly applied to add to the current body of literature as well as to justify the vision and direction of the present effort.

2.1 Weiguang Zhu (1993)

According to Weiguang Zhu use of Tin-coated tools helps in the reduction of heat partition into the cutting tool in comparison to uncoated tool about 17 percent at conventional cutting speed.

2.2 Nickel et al. (1999)

According to them various investigations have been done over the years on the nature and the wear mechanisms of TiN-coated tools. Also the role of TiN in improving wear resistance and increasing tool life is under constant research. For example, the wear modes of TiN-coated HSS, from the results of sliding pin-on-disc wear tests, were found to include adhesive and abrasive wear of the coating w12,13x. TiN-coating fragments were found to be of the dominant wear mechanisms when actual machining tests w8x was done. The latter wear mechanism was because of insufficient adhesion.

2.3 S. PalDey (2003)

According to S. PalDey the review of deposition of (Ti,Al)N coatings using different PVD techniques have been done. He has analysed the effects of deposition variables on coating microstructure and film properties. (Ti,Al) N exhibited better performance in many applications when compared with the other commercial Ti based coatings. Many different strategies were adopted in order to improve or adapt hard coating which are based on a simple TiN coating.

2.4 CemKaracal et al. (2009)

According to CemKaracal et al. there is a significant improvement in tool life expectancy with advancement in coating technology. Titanium Nitride

(TiN), Titanium Aluminum Nitride (TiAlN or AlTiN), Titanium Carbo-Nitride (TiCN), Chromium Nitride (CrN), and Diamond coatings are able to increase the overall tool life with decrease in cycle time and can provide better surface finish.

2.5 RogerioFernandesBrito et al. (2009)

According to them an analysis was done on thermal properties three different & three layers of titanium carbide, (TiC), aluminum oxide (Al2O3), and titanium nitride (TiN), individually and in group while considering every layer with equivalent thermal properties. Tools with coating and without coating of titanium aluminum nitride (TiAlN) and aluminum chromium nitride (AlCrN), were used in the turning process of AISI 4340 steel.

2.6 C. Chim1 et al. (2010)

C. Chim1 et al. States that the coatings of TiAlN, TiN, CrAlN and CrN were deposited over the tool by vacuum arc. They were investigated for thermal stability and oxidation resistance after its annealing in air at different temperatures ranges of (500°C-1000°C). CrAlN and TiAlN showed better resistance to oxidation than their binary counter parts CrN and TiN. The coatings which were based on Chromium (Cr) showed much better oxidation resistance than the coatings which were based on Titanium (Ti).

2.7 L. B. Abhanget. al. (2010)

Using the tool-work thermocouple technique they worked for measuring the tool-chip interface temperature with a experimental setup during turning of EN-31 steel alloy with tungsten carbide inserts. The mean tool chip tool interface temperatures have been studied experimentally using the above mentioned tool work thermocouple technique. This method has been highly successful in determining and indicating the effects of the cutting speed, depth of cut, feed rate and the tool parameters on the temperature. In tool-work thermocouple technique, the tool-chip interface becomes the hot junction, while the end of the tool becomes the cold junction. The electrical insulation of cutting tool and work pieceneed to be done from the machine tool.

2.8 Abdul Kareem Jaleel et al. (2012)

Abdul Kareem Jaleel et al. states that the various hard coating are used over the cutting tools such as TiC, AL2O3and TiN have been used. The importance of high speed machining process is constantly increasing. Therefore some of these new techniques can be easily applied in place of traditional/conventional methods of machining for the manufacturing of variety of components. They can be employed at low cost or can even making entirely new type products, e. g. machined from brittle materials.

2.9 K. Aslantas et al. (2012)

According to K. Aslantas et al. the research on coated mixed ceramic tool provides the information that with the increase in the temperature, the thermal conductivity value of TiN coating material increases. The temperature gradient between to two sides of chip decreases and thus the chip up-curl radius increases.

2.10 Sushil D. Ghodam (2014)

They worked on the measurement of temperature of cutting tool during turning operation with the use of a tool-work thermocouple. The temperature of the cutting tool at the point of contact is an important factor in the control of machining process. With the advancement in the machining operation, special focus on the life of a tool is done. It became very important to get the knowledge of the temperature measurement at the turning tool tip with the change in various cutting conditions and parameters. A thermocouple of K-type which was embedded in the work piece was used to convert measured emf to the temperatures of the interface. The main objective of this experiment was the comparison of the temperature generation during machining process without any coating and with CVD coated tungsten carbide cutting tool. As the feed rate increased the temperature of the uncoated tool increased more amount in comparison to coated tool.

2.11 MeenuSahuet. al (2014)

They have developed an optimization method for the various cutting parameters (cutting speed, feed and depth of cut) in dry turning of AISI D2 steel to get the minimum tool wear, maximum material removal rate (MRR) and low work piece surface temperature.

2.12 Ved Prakash Singh Parihar (2015)

According to Ved Prakash Singh Parihar during a machining process the cutting can pose a serious problem which influences the quality of manufactured parts, tool service life, precision, performance of lathe machine and cutting rates. Their researchshows the analysis of mechanics involved during turning process. Cutting forces have a huge impact on the stability of cutting process, and which finally affects the quality ofthe parts which are manufactured and productivity rates. The cutting force which is applied by the tool of the lathe machine on the work piece was measured using an experimental setup. The forces gets distributed on the work piece in three directions in axial, longitudinal and lateral directions.Dynamometer can also be used to measure the cutting forces. This experiment was performed by making change in the three parametersof cutting process which aredepth of cut, feed and spindle speed and their effects was analysed on cutting forces with the change in parameters.

2.13 Rahul Chopra et al. (2016)

According to Rahul Chopra et al. Cryogenic treatment (CT) is new and supplementary process in comparison to conventional heat treatment process in steels.It is done by deep–freezing materials at cryogenic temperatures which enhance the physical and mechanical properties of materials which were being treated.

2.14 Safal A. Shambharkar et al. (2016)

This research paper highlights the major effect of the temperature and cutting forces generated on the tip of the Single Point Cutting Tool (SPCT) during cutting operation. In an experimental setup, the measurement of temperature is done by using thermocouple at various depth of cut. It was observed that with the increase in depth of cut temperature also increases. It also gave the deformation of the tip of the tool. The Finite element analysis of single point cutting tool shows the result that the maximum stresses are generated at the tool tip and it is the main cause of its failure. Also the deformation at the tool tip is maximum which makes the tool tip blunt and finally leading to its failure.

2.15 Bharath H S et al. (2017)

According to Bharath H S et al. the cutting tool has a significant role to play in the machining process of a part. It helps in achieving the desired accuracy level and surface finish in a machining operation along with the cutting. The tool should be stronger enough to perform the tast of cutting and withstand the wear and should also have a longer life so that its economical use can be done to produce large number of components with the same accuracy. Efficient machining operation is important in metal manufacturing process in order to achieve near-net shape, exceptional dimensional accuracy, and economical production and for aesthetic requirements. In modern machining process the use of CNC has played a major role machining process and has significantly improved dimensional accuracy, speed, accuracy and has reduced the forces on cutting tool, lead time and amount of workforce required. Most of the reputed institutions have a long experience of making cutting tool having strong cutting tip and longer life. They are continuously doing research and development for the optimisation of tool material and its shape for the proper economical usage, as the economical production and usage is the need of the present manufacturing industry. The results which were obtained after the experiment explained that the single point cutting tool which was forged and heat treated HCHC performs in the similar manner to HSS tool but at higher temperature it performs even better than H.S.S. tool with higher tool life.

7. Conclusions

In the present work results for Equivalent Stress, Maximum Principal Stress and Shear Stress Of Single Point Cutting Tool At .2mm, .5mm and 1 mm Depth Cut For all four material (1037 Carbon Material, Chromium Steel, Tungsten Carbide And T-42 H.S.S) shows that Tungsten carbide have lowest value in share stress,Equivalent stress and maximum principal stress by which it is best suitable tool material for single point cutting tool. This work highlights that as the depth of cut increases, the stresses developed in the tool increases. It is the main reason for tool failure. The deformation also noted as higher side with every interval of rise in depth of cut. It is also one of the reasons for tool failure. As the depth of cut is increased further from .2 mm to 1.00 mm stresses are set up in the tool, due to which the geometry of the tool gets affected and the tool becomes unusable.

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