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Design and Analysis of Single Point Cutting Tool to Increase Tool Life

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Abstract:- Today lots of manufacturing companies are use single point cutting tool with inserts. Inserts which is generally made up of diamond, ceramic etc. But the cost of these inserts very high and it is not affordable for small scale industries. In this study discuss about various methods like PVD or CVD and Cryogenic hardening also change the design of tool. Find out which method is best which means economical, efficient and easily performable.

Keywords:- *PVD, CVD, Cryogenic Hardening, Economical, Analysis, Geometry.*

I. INTRODUCTION

Now a day all cutting tool manufacturer are still finding how to increase tool life. If discussing about the tool life or the factor affecting the tool, like cutting speed, depth of cut, tool geometry or tool material. If providing more depth of cut while performing turning operation it cause more tool wear and tool life get reduce so in this way other factor are also affected on tool life.

Fluidization method is very old process for increasing the life of tool. In fluidization method cutting fluids are use like water, liquid nitrogen, oil water etc. In this method cutting fluids are pouring at the point of machining for reducing the stress and temperature [1].Fluidization method is the best way for reducing the temperature at machining point. Because this temperature increases the cutting forces and tool life get reduce [2].

Generally PVD or CVD this coating methods are also use. In which PVD stand for physical vapour decomposition and CVD stand for chemical vapour decomposition this is form thin layer over the surface of cutting tool [2]. Discussing about some other process cryogenic treatment process is also use for improving tool life. Cryogenic hardening is a part of cryogenic treatment process in which material are slowly cooled under a very low temperatures producing by using liquid nitrogen other liquids are also but Liquid nitrogen is a harmless gas that why liquid nitrogen is use [3].

- *Tool Life*

Actual time between two successive regarding is known as tool life. What is actual time and regarding let's discuss about it.

- *Tool Failure*

When the tool is unable to perform the cutting operation properly then it is called as tool failure.

When a single point cutting tool fitted over the tool post of lathe machine and performs turning operation. After some time tool does not perform turning operation properly then it is called as tool failure.

After tool failure remove the tool from the tool post and regrinding the tool and use again then again regarding tool after the again tool failure so this is the time between two successive regarding.

Let's discuss about the actual time it is also called as effective time. So actual time is a total time accepts ideal time of man, machine, and tool.

II. LITERATURE REVIEW

[Miroslav Zetek*, Ivana Zetková] they said that the fluidization method is use for increasing the efficiency of cutting tool and this method is old method which is use for standard surface modification but it never was been use for surface modification of the cutting tool. So test result were be obtain is that the material properties are very close to standard cutting tool properties but during the real testing problem came in the life of cutting tool was decrease. So result from the material or the real testing are different it could be cause by different testing condition.

[A. Shokrania, V. Dhokiaa, S.T Newmana, R. Imani-Asraia] they said that a series of experiments were conducted using PVD TiAIN coated solid carbide end mills which is used in CNC milling. Cryogenic cooling is applied on the cutting tool for checking the effects of cryogenic cooling on the solid carbide end mill which is already PVD TIAIN coated. After cryogenic cooling the result were obtained is that 33% and 40% reduction in Ra and ISO Rz surface roughness of the machine parts as compare to dry machining without noticeable(1.9%) increase in power consumption of the machine tool. Even doing improvement in surface roughness of the machine parts cryogenic cooling significantly reduces the life of coated solid carbide end mills.

[Sushil D. Ghodam] said that the tool work thermocouple technique is used for measuring the temperature of coated and uncoated tool while turning. The tool work thermocouple is easy to install and inexpensive

technique as compare other methods. When increase the cutting speed or feed rate, the temperature at the tool rake face also increases as found in the machining test. Due to the advancement in machining processes the generation of heat at tool rake face takes place. This generation of heat is decrease by using coated tools. So reduction in the temperature of the tool increases the strength and also increases surface roughness of the cutting tool. So this paper said the coated tools are very efficient as compare to uncoated tools

[N. Balasubramanyam1, Smt. G. Prasanthi and M. Yugandhar] In this paper a comparison of some coatings are conducted for finding out which coating properties are very efficient for cutting tool. The mechanical, Tri bological properties test have conducted as per ASTM standard as the result of that comparison the AlCrN coating is applied on the cutting tool and this AlCrN coating allows recrystallization and crystal growth, enhancing its wear behaviour. These characteristics make the coated tool better for cutting applications. By means of AlCrN coating the low coefficient of friction of cutting tool as seen while machining. And the AlCrN-T coating has a wide potential tri bological application under the condition of sliding wear and this AlCrN-T coating can be used with a high level of productivity in the machining of aerospace and biomedical components with sufficient process parameters, lubrication and other condition.

[**Tushar Mamodia Rahul Maghanti** In this paper a cryogenic treatment experiment where done on HSS and tool steel cutting tool. As a result of that experiment cryogenic treatment cannot make only easier the carbide formation and increase the carbide population and volume fraction in the martensite matrix, but can also make the carbide division more similar. By means of cryogenic treatment the life of tool get increased by 19% for M2 grade HSS single point cutting tools and 17% for carbide inserts for machining mild steel after the cryogenic treatment, but the tool becomes brittle after the cryogenic treatment. In SEM(Scanning electron microscope) analysis, as a result of that refinement of carbide is more in case 9f cryogenically treated HSS tools as compare with untreated tools. So after the cryogenic treatment the life of tool get increased by in increasing its hardness but the tool get little brittle after the cryogenic treatment.

III. METHODOLOGY

In this world their various methods are used for improving the life of tool, for Ex PVD or CVD and fluidization method also but which method is the best that's problem.

In this research find out the particular method which is efficient, economical or easily performable for every person.

A. PVD or CVD

Let's start from the method of PVD or CVD this is a coating method. PVD stand for the physical vapour decomposition and CVD stands chemical vapour decomposition.

In PVD consist of metallic reactor into the reactor the tools are placed. At the upper side of the reactor ionization chamber is place. In which material or metals are melts at high temperature and it get ionized. This ionized metals are transmit into the metallic reactor and this metals are form a thin layer over the surface of tool or inserts. This layer vary about 2 to 6 micron [2].

In CVD process the inserts or tool are put into the furnace. Then various gasses like Nitrogen, Co2, Methan, Hydrogen etc are passing through the furnace. After passing this gasses the thin layer of Tin, Aluminium Oxide, Titanium Carbide this layer are form over the surface of tool or inserts [2]. Thickness is varying from 2 micron to 20 micron.

B. Cryogenic Hardning

Now a next process is cryogenic hardening process it is an inexpensive and permanent treatment which follow the conventional heat treatment cycle [3]. In cryogenic hardening method in which liquid nitrogen are use for heat treatment. In this method tool are immersed into the liquid nitrogen for some time then check the hardness of the cutting tool by using Rockwell hardness testing machine.

Tool Used	Duration (Hrs)	Reading(RHS)
Single point cutting tool(HSS)	12	62
Single point cutting tool(HSS)	24	64
Single point cutting tool(HSS)	48	66

Table 1

The excrement performs on the single point cutting tool which is made by high speed steel. First take a initial reading of the tool which is came about 62 RHS. Then immersed tool into the nitrogen liquid for 12 hrs then the reading came at about 62 RHS which means there is no change in hardness of the tool as show in table.

When tool are immersed into the liquid nitrogen for 24 hrs then the reading are came about 64RHS which means improvement in hardness. Then kept tool into nitrogen for 48 hrs then the reading came about 66RHS.

By doing the cryogenic hardening process the life span of tool get increase with hardness, toughness [3].

C. Design of Single Point Cutting Tool and its Analysis

The equation of motion of cutting tool is solved using FEA tool (ANSYS) as the equation of motion for a cutting tool is difficult to visualize therefore some FEM tool is the solution method for analysing stress of cutting tool with

various aspect ratio. The ANSYS 16 finite element program was used for stress analysis. For this purpose, the key points were first created and then line segments were formed. The lines were combined to create an area. Finally, this area was extruded a We modelled the cutting tool with a different tool signature .A three-dimensional structural solid element was selected to model the cutting tool. The cutting tool was discretized into 8811 elements with 10710. The cutting tool boundary conditions can also be modelled by constraining all degrees of freedoms of the nodes located on the left end of the cutting tool. For bending and contact stress analysis the cutting tool with the properties given in table 1 was chosen to model. To minimize computation time, meshed gear with one tooth is imported to ANSYS Workbench 16 for analysis)

Cutting tool parameters:
Material Uncoated cemented carbide
Young's modulus (GPa): 534
Poisson's ratio: 0.22
Density (kg/m3): 11900
Thermal conductivity (W/m ◦C): 35.95 + 0.042T
Specific heat (J/kg ◦C): 334.01 + 0.12T

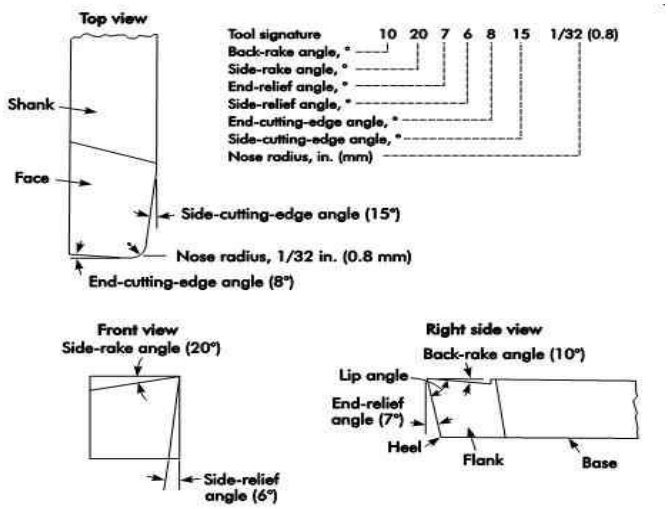


Fig 1

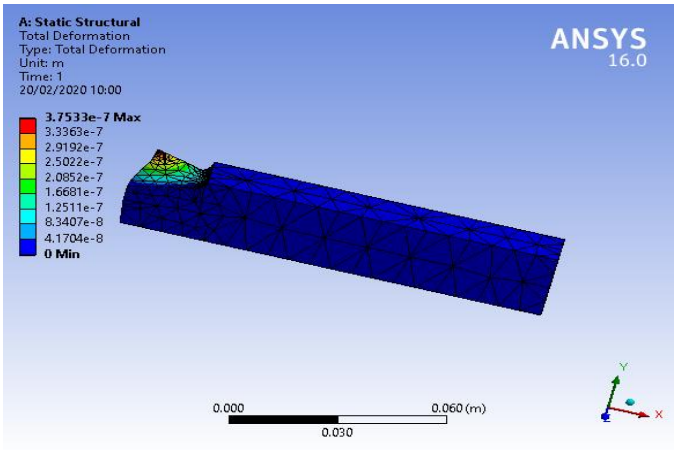
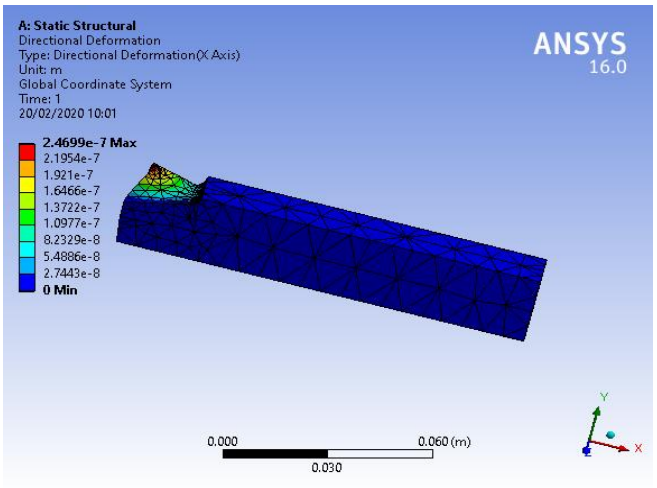


Fig 2



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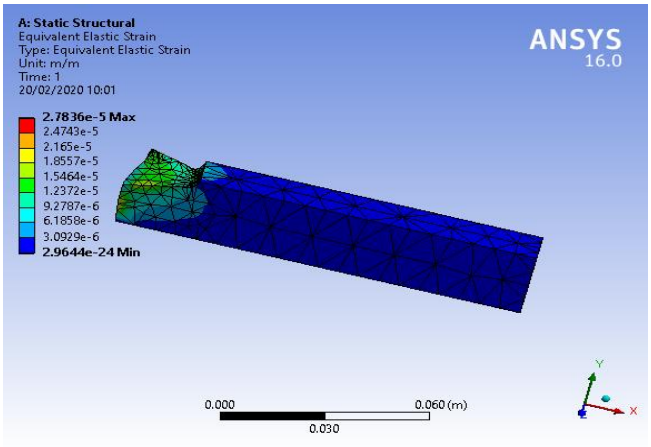

Fig 4

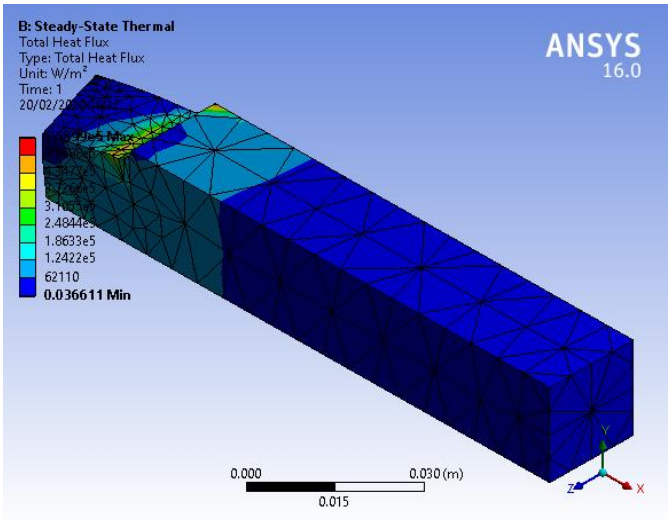

Fig 5

IV. CONCLUSION

In this study discuss about the tool life and also see the various methods like PVD or CVD and cryogenic hardening and improve the tool geometry to increase tool life.

- PVD or CVD and cryogenic hardening are the coating method which is use for increasing the efficiency of the tool.
- To improving the wear resistance PVD or CVD this coating method are uses which is form a thin resistance layer over the surface of inserts and this method are help for improving the wear resistance.
- In case of normal single point cutting tool cryogenic hardening is best because it is less economical and easy to perform.
- To change the geometry of tool like, nose radius, rake angle which reduced the tensile stress and improves the performance of tool.

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