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Vibration Analysis of Single Point Cutting Tool on Lathe Machine by Using FFT Analyzer

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ABSTRACT: The present work concentrates and aims on study of different controllable parameter that affects the responses like vibration amplitude. The prediction of vibration between the tool and work piece is important as guideline to the machine tools user for an optimal selection of depth of cut and rotation of spindle to minimize the vibration. Machining is a complex process in which different parameters can deleterious the desired result. Among them, cutting tool vibration is an important which influences dimensional precision of components machined, life of the cutting tool is very important. Cutting tool vibration are mainly produced cutting parameters like cutting speed, depth of cut and tool feed rate. In this work, the cutting tool vibrations are controlled in lathe machine where the tool holder is supported with and without damping pad. The cutting tool vibration signals were controlled through FFT analyzer. To predict and validate result by using Taguchi method, Experimental studies and data analysis have been performed to validate the proposed damping system. By using regression analysis best suitable equation is developed to predict the probable value response for given predictor value.

KEYWORDS: life of the cutting tool, Four Channel B & K's FFT Analyzer & cutting speed, depth of cut and tool feed rate.

I. INTRODUCTION

Metal cutting or simply machining, is one of the oldest processes for shaping components in the manufacturing industry. To remain in business, manufacturing companies have to machine the components at required quality with minimum possible cost and hence the tool life becomes a most important aspect for manufacturing engineers and researcher. The challenge of modern machining industries is focused mainly on the achievement of high quality, in terms of work piece 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 environmental impact. Tool wear weakens the cutting tool, increases the forces used in cutting and causes a lack of consistency in material removal. Machine and machine tool are always subjected to vibration. These vibrations are mainly causes due to Inhomogeneity's in the work piece material Variation of chipcross section Disturbances in the work piece or tool drives Dynamic loads generated by acceleration/deceleration of massive moving components Vibration transmitted from the environment Self-excited vibration generated by the cutting process or by friction (machine tool chatter). The tolerable level of relative vibration between tool and work piece, is determined by the required surface finish and machining accuracy as well as by detrimental effects of the vibration on tool life.

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II. OBJECTIVE AND PROBLEM DEFINITION

1. Objectives

- 1) To measure the vibrations of HSS single point cutting tool.
 - 2) To measure the vibrations of Carbide tipped single point cutting tool.
 - 3) To find the better tool with cutting parameters for maintaining good surface finish.
- Vibration Analysis of Single Point Cutting Tool On Lathe Machine By Using FFT Analyzer Department Of Mechanical Engineering T.K.I.E.T., Warananagar.

2. Problem Statement-

Vibration of cutting tool affects surface finish quality of component which is under machining. If vibrations are beyond limit and acceptance level chattering will be developed. These vibration of cutting tool depends upon cutting speed and depth of cut and finally come with conclusion.

III. METHODOLOGY

The most readily controlled parameters in cutting operations are cutting speed, depth of cut, feed rate. Consideration the vibration generated during machining operations. In the current study, an attempt is made to relate the surface roughness with the vibration level of the machine tool. Machine tool's vibration amplitude measurements can be done by considering any one amongst displacement, velocity, and acceleration. To do this, one accelerometer can be placed near or at the tip of the cutting tool. It will help in collecting or recording enormous information by recording the difference of vibration levels. If the two signals collected are in phase and are of the same amplitude, there would be definitely rigid body motion and no relative motion happening between the cutting tool and work piece. Therefore as a first order approximation, this is a required condition for correcting this problem in the machine tool. If however, there are big differences in the vibration phase and or amplitude of the motions, there would definitely be larger levels of errors in the cutting operation. Machining operation, straight turning, is selected for this study. In a straight turning machine operation, a single point cutting tool takes away material in the form of chips from the outer surface of a rotating cylindrical bar. The experimentation was, carried out by measuring acceleration amplitude.

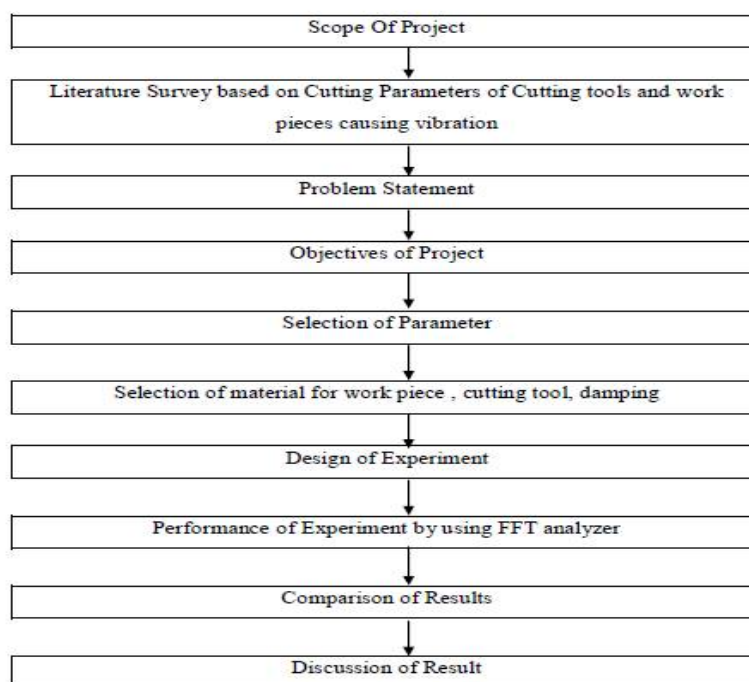


Fig. No.1 Methodology Flow Chart

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IV. DETAILS OF EXPERIMENTAL SETUP

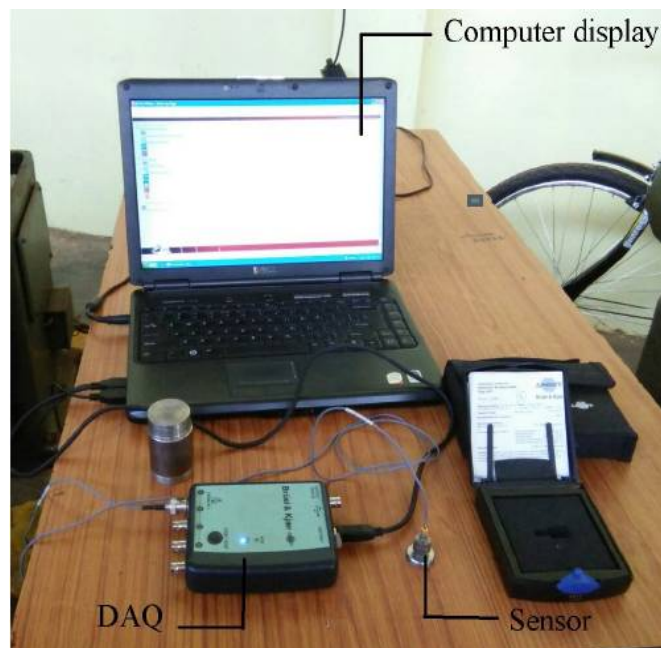


Fig. No.2. Experimental Setup

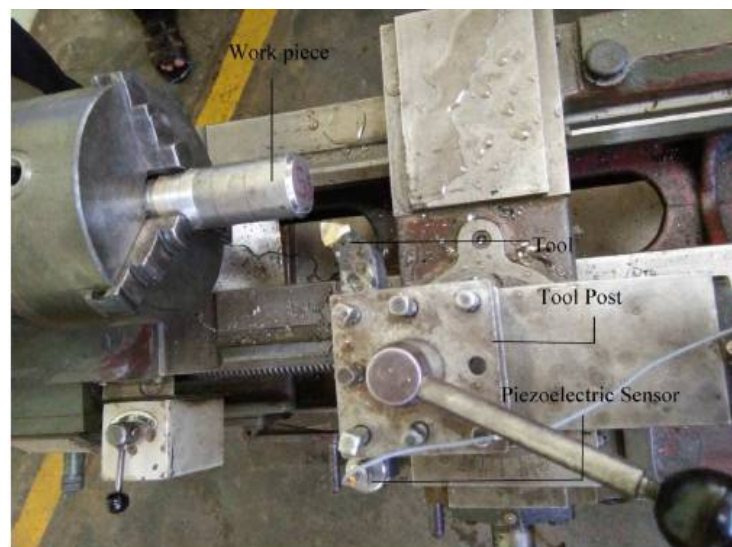


Fig. No.3 Piezoelectric Sensor is placed on the tool post on Lathe.

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V. EXPERIMENTAL RESULTS

3. SPECIFICATIONS AND TOOL GEOMETRY

- 1) **Back Rake Angle** – It is the angle between the face of the tool and a line parallel to the base of the tool and measured in the plane through the side cutting edge.
- 2) **Side Rake angle**- It is the angle between the tool face and a line parallel to the base of the tool and measured in plane perpendicular to the base and the side cutting edge.
- 3) **End Relief Angle**- It is the angle between the portions of the end flank immediately below The edge of cutting edge and a line perpendicular to the base of the tool and measured at right angle to the end flank.
- 4) **Side Relief Angle**- It is the angle between the portion of the side flank immediately below the side cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the side flank.
- 5) **End Cutting Edge Angle**- This is the angle between the end cutting edge and a line normal to the tool shank.
- 6) **Side Cutting Edge Angle**- It is also known as lead angle is the angle between side cutting edge and the side of the tool shank.

Table No.1 Tool Specifications

	HSS tool	Carbide tip tool
Back Rake Angle	12°	0°
Side Rake Angle	12°	10°
End Relief	10°	6°
Side Relief	10°	6°
End Cutting Edge Angle	30°	8°
Side Cutting Edge Angle	15°	90°
Nose Radius	0.8mm	1mm

4. Material Specifications

Table No. 2. Chemical Composition of Material

Carbon	0.16-0.18%
Silicon	0.40%max
Manganese	0.70-0.90%
Sulphur	0.040%max
Phosphorus	0.040%max

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Table No. 3. Process Parameters

Process Parameters	Levels I	II	III
Cutting Speed (rpm)	680	395	225
Feed(mm/rev)	0.046	0.046	0.046
Depth Of Cut(mm)	0.5	1	1.5



(A)-CARBIDE TIP TOOL



(B) HIGH SPEED STEEL TOOL

EXPERIMENTAL ANALYSIS

For experimental analysis we change 3 depth of cut for single spindle speed of lathe machine. We selected minimum auto feed configuration for longitudinal propagation of 0.046 (mm/rev). Selected Speeds are of high level speed of lathe machine which got by changing belt position on stepped cone pulley drive.

Project File Name: Carbide tip single point cutting tool

Speed = 225 rpm

Depth of cut = 0.5mm

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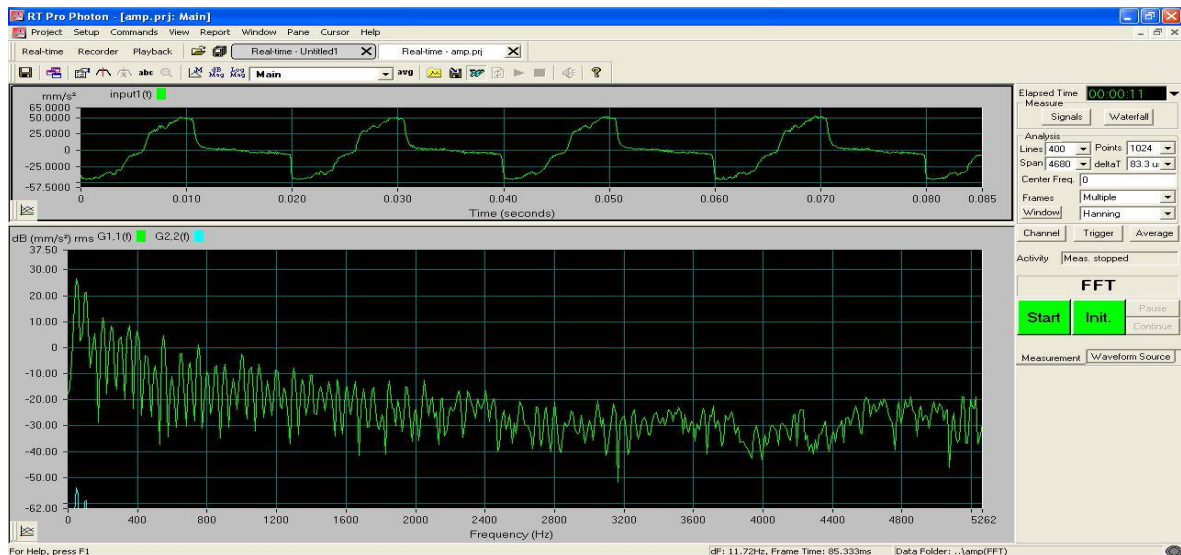


Fig. No. 4. Frequency Vs Amplitude graph on FFT Analyser.

VI. RESULTS

Table. No. 4. Comparison between Carbide tip tool and HSS tool

Speed (rpm)	Depth Of Cut(mm)	Max. Amplitude(mm/sec²) For Carbide tool	Max. Amplitude(mm/sec²) For HSS tool
225	0.5	188.4	53.75
	1	190.4	57.5
	1.5	191.5	62.5
395	0.5	190	53.5
	1	186	57.5
	1.5	184	66.25
680	0.5	187.5	50
	1	195.83	50.662
	1.5	200.10	58.75

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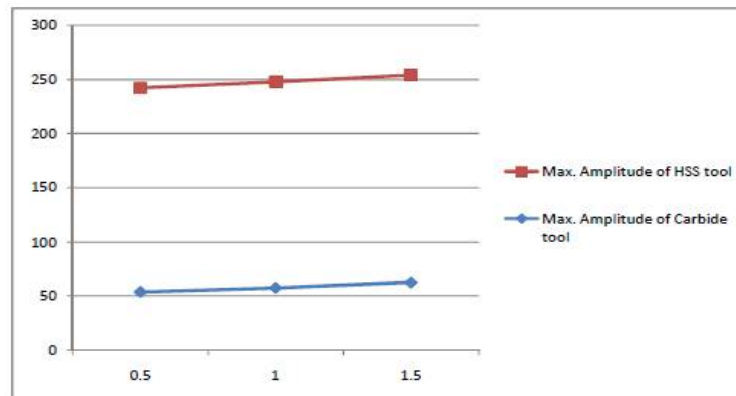


Fig. No. 5. Max Amplitude of tool vs Depth of Cut.

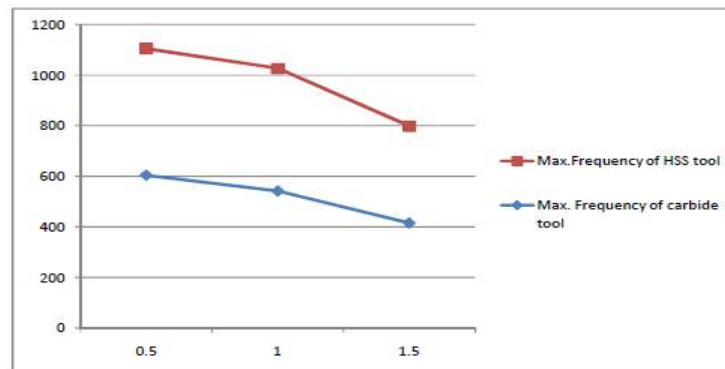


Fig.No.6.Max Frequency of tool vs Depth of Cut

VII. CONCLUSION

From the result table the graph (depth of cut vs max. amplitude) and (depth of cut vs frequency) is plotted as shown in figure. From this graph following conclusion can be drawn

- As depth of cut goes on increasing the amplitude of vibration for both HSS and Carbide Single Point Cutting Tool goes on increasing that is amplitude is proportional to depth of cut
- As depth of cut goes on increasing frequency goes on decreasing for both HSS and Carbide Tool that is frequency is inversely proportional to depth of cut.
- For Carbide tools have vibrations with low amplitude as compare to HSS tool.
- Carbide tipped Single point Cutting tool gives better surface finish as compared with High Speed Cutting Tool.

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