Chatter Measurement on Turning Cutting Tool Using Piezoelectric Ceramic Material

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Abstract

Machining is a complex process in which many factors affect results. Chatter produced is undesired in all kinds of machining process as it directly affects surface finish and tool life. Tool condition monitoring has gained substantial importance in the industries in past few years, as it significantly influences the economy process and the quality of machining surface finish. Advancement in the technology has led to the develop of various methods to improve surface quality by reducing vibration. For this various kinds of sensors and transducers are introduced in the machining to sustain tool performance These sensors are characterized by their measuring capability and accuracy.Among them, cutting tool material, feed rate, cutting depth, spindle speed and cutting angle are involved. All these deleteriously affect result by producing vibration. Vibration is the most adverse phenomenon which influences surface finish quality, precision of the components machined and life of the cutting tool. Small patch of piezoelectric ceramic material is successfully incorporated into turning cutting and examine to to reduce vibrations in machining processes.

Keywords : Chatter Measurement, Condition Monitoring, Piezoelectric Ceramic

Introduction

Tool life importance cannot be denied, it is influenced by vibration produced during machining. During the machining process both the cutting tool and work piece confront severe vibrations which are known as chatter. It highly causes harm to tool life and desired surface finish. Intense chatter, in the working environment of the tool is usually because of relative movement of the cutting tool and the work piece. In all cutting operations including turning, vibrations are produced due to the deformation of cutting tool edge and work piece. Chatter produced as a result of cutting operation on machines in tools results to decrease tool life. It also results economical loss as well as environmental. During this phenomenon unbearable noise is also produced. Chatter vibrations critically affect tool life, surface finish and production rate in machining processes. regeneration and mode coupling were numbered as the major cause for tool chatter (Davies, et. al. 2000).chatter and rate of production are directly related to eachother.to reduce chatter from metal removing process, small depth of cut is given. Machine-tool vibrations are not in regular in pattern they depend on tool material, cutting position and design and geometry of both the work piece and cutting tool (Merritt, 1965). the piezoelectric sensor and actuator approach provides numerous benefits which includes material,cost,design flexibility and better surface finish (Turner, et al. 1994). Improvement in design flexibility and better production rate can be achieved by eliminating tool vibration error in all kinds of cutting machines. It can also reduce industrial waste which will ultimately save money. By incorporating smart structures into the cutting tool and work piece in various machining process we can easily control chatter (Rashid, 2005).various scientific groups are working on it as it can result to achieve satisfactory results.

Experimentation

The experimental setup is shown in the Figure 1 &2 .Vibrationmeter is attached with cutting tool. Turning cutting tool is designed with high strength steel 4340. Vibration meter is used to analyze the displacement amplitude of vibration produced during turning operation. First of all, tool without piezoelectric patch is used to study. After that piezoelectric patch is attached with turning cutting tool and readings are taken

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Figure 1 : Experimental setup on Bl115

Figure 2 : Experimentation and readings with vibrationmeter

Turning tool is fixed; the readings of vibration are calculated from vibration meter. Values are collected and tabulated in Table 1 &2 for displacement at various feed rate and spindle speed.

Table 1 : Feed rate and displacement values for simple cutting tool

Sr. No.	Feed rate	Displacement
1	0.08	0.11
2	0.1	0.15
3	0.12	0.185
4	0.14	0.21
5	0.16	0.25
6	0.18	0.27
7	0.2	0.87
8	0.22	1.46
9	0.24	2.07
10	0.26	2.15

Table 2 : Spindle speed and displacement values for simple cutting tool

Sr. No.	Spindle speed	Displacement
1	50	0.048
2	70	0.065
3	100	0.073
4	200	0.08
5	300	0.12
6	400	0.154
7	500	0.17
8	700	0.225
9	1000	0.25
10	1200	0.39

Figure 3 & 4 clearly shows that the displacement in vibration amplitude increase as the feed rate and spindle speed is Increased.

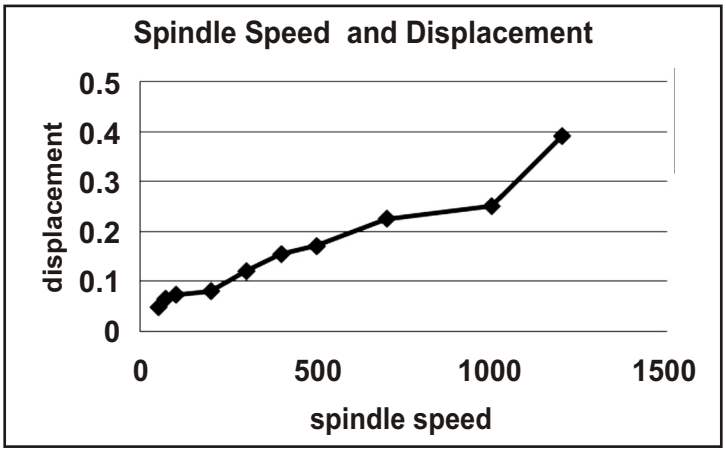

Figure 3 : displacement and spindle speed of simple cutting tool

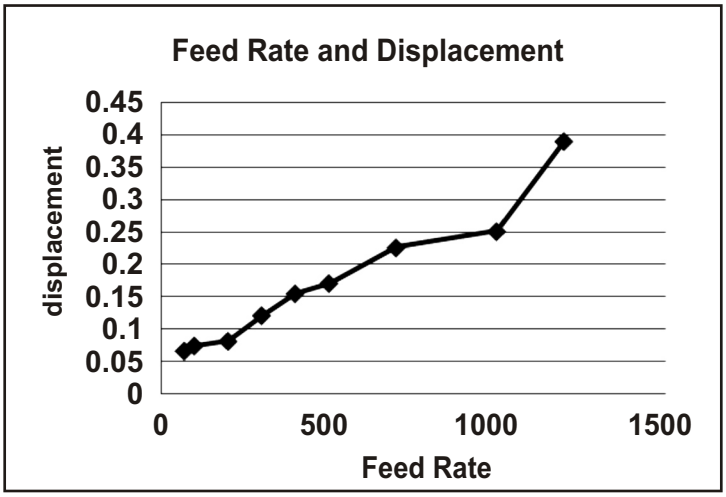

Figure 4 : feed rate and displacement of simple cutting tool

The experiment is repeated on same feed rate and same spindle speed using pizeoelectric patch. Pizeoelectric patch is connected with cutting tool but insulated through mica sheets.steel strips are used to take voltage from voltmeter .This assembly is than fixed on tool post and values collected are indicated in Table 3 & 4.

Table 3 : Feed rate and displacement values for PZT designed cutting tool

Sr. No.	Feed rate	Displacement
1	0.08	0.092
2	0.1	0.13
3	0.12	0.165
4	0.14	0.183
5	0.16	0.197
6	0.18	0.21
7	0.2	0.45
8	0.22	0.73
9	0.24	1.04
10	0.26	1.53

Table 4 : Spindle speed and displacement values for PZT designed cutting tool

Sr. No.	Spindle speed	Displacement
1	50	0.024
2	70	0.037
3	100	0.045
4	200	0.0557
5	300	0.062
6	400	0.069
7	500	0.072
8	700	0.074
9	1000	0.08
10	1200	0.1

The trend shown in Figure 5 & 6 clearly showing that a decrease in displacement occurs if we use piezoelectric material 5A ring of 1 inch, Displacement increases as feed rate and spindle speed increases.

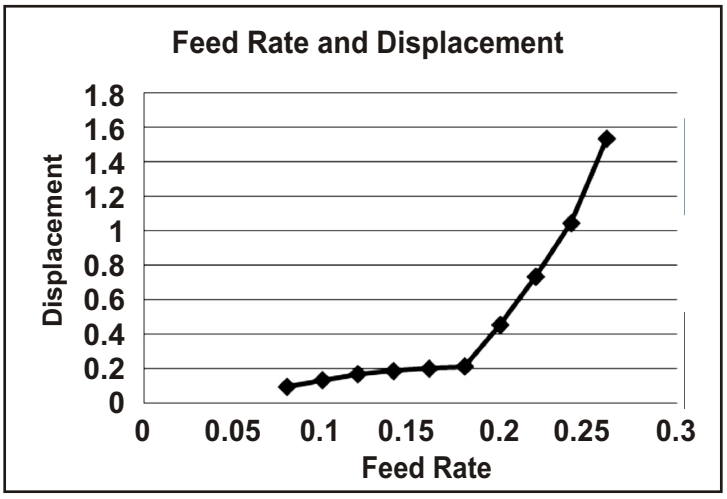

Figure 5 : Displacement and feed rate with pzt

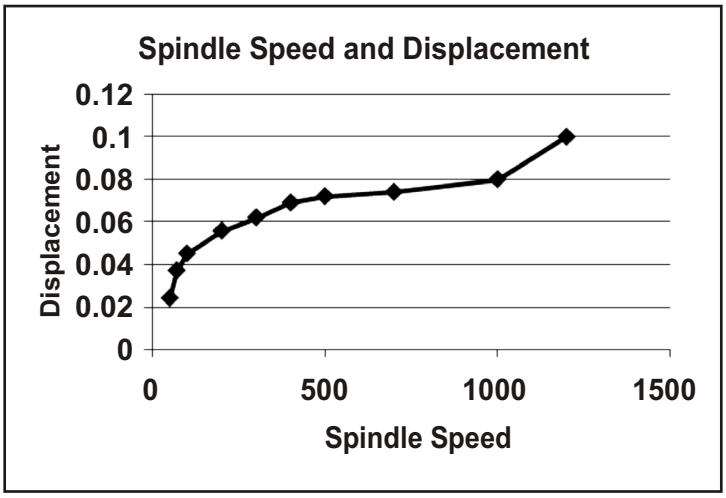

Figure 6 : Displacement and spindle speed with pzt

The comparison between both turning cutting tool vibrations at feed rate and spindle speed without and with piezo material are indicated in Figure 7 and comparative less displacement has been found in case of piezo attachment.

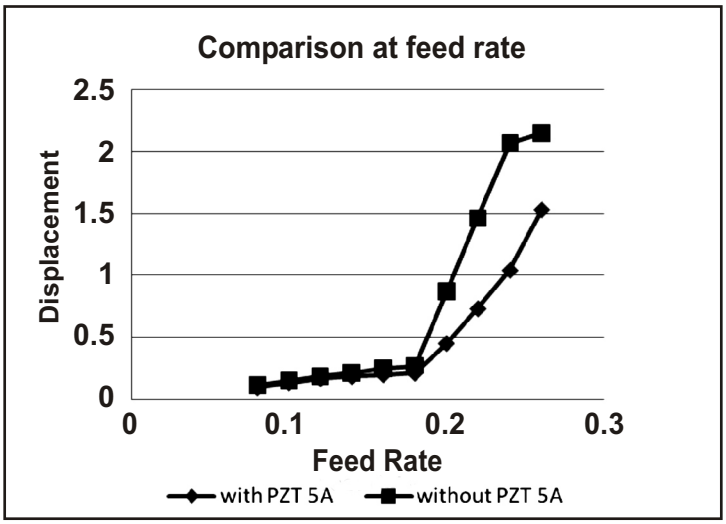

Figure 7 : comparison between with and without pzt cutting tool at feed rate

The Figure 8 clearly depicts that displacement amplitude is lower in case of pzt material. The decrease in displacement case of spindle speed is remarkable.

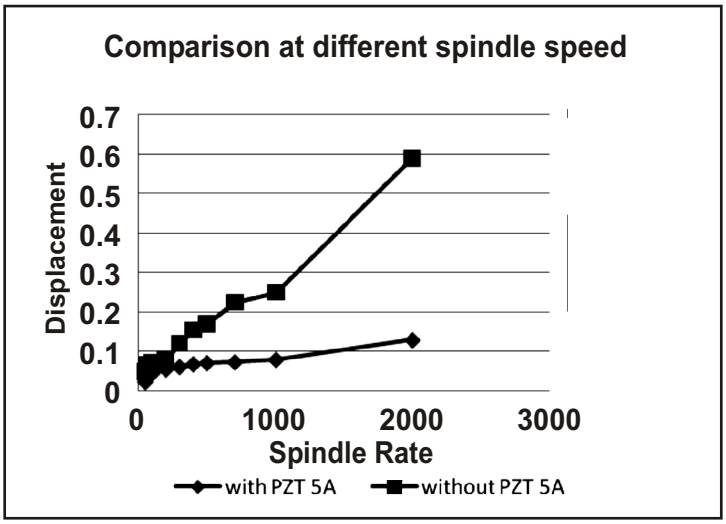

Figure 8 : comparison between with and without pzt cutting tool at various spindle speed

Conclusion

The feed rate and spindle speed are directly proportional to the amplitude of vibration. Both factors play an important role in producing vibration as their values are increased. But vibration produced in the turning tool without piezoelectric patch is slightly higher as compare to the tool with which piezoelectric patch is attached. Amplitude of vibration is lower in case where PZT material is used. It is therefore concluded that by using the piezo patches the displacement and amplitude can be controlled in cutting tools. Moreover the voltage generated by piezo materials can further be utilized.

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The title of the paper should be concise and definitive.

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Sample References

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