NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 3, ISSUE5, MAY-2016

EVALUATION OF TOOL LIFE IN FACE SERRATION OPERATION

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ABSTRACT

As an important part of CNC machine, cutting tools will be aging in the long-term operation. The reliability of cutting tools influences the whole manufacturing effectiveness and stability of equipment. The selection of proper cutting tool and corresponding process parameter is key task in any type of manufacturing. In this paper an attempt is made for evaluation of tool life in face serration operation on cable housing. The part name as cable housing & part no.-108885 selected for doing face serration & the suitable size of Aluminium-6061-T6 material of Ø 35 mm & of 800 mm in length is used. Then the face serrations of V-type of 100° done by V-type of form tool of having same 100° profile. Also it attempted to correlate the tool life and process parameter with productivity. Tool wear monitoring is important in machining industries for controlling the quality of machined parts that helps to improve the productivity

INTRODUCTION

Machining is the most important part of the manufacturing process. Machining deals with the process of removing material from a work piece in the form of chips. Machining is necessary where tight tolerances on dimensions and finishes are required. The common feature is the use of a cutting tool to form a chip that is removed from the work part, called Swarf.

In machining, it is often difficult to select appropriate tools (tool holder and insert), machining parameters (cutting speed, feed rate and depth of cut) and tool replacement times for all tools due to the wide variety of tooling options and the complexity of the machining operations. Of particular interest are the complex interrelationships between tool selection, cutting data calculation and tool life prediction and control.

Wear of a cutting tool in a machining operation is highly undesirable because it severely degrades the quality of machined surfaces and causes undesirable and unpredictable changes in the work geometry.

Whatever may be the manufacturing process used, it is not possible to produce perfectly smooth surface. Hence, the improved qualities of product and the economics of the manufacturing operation are very important consideration to produce product having the functional and visual appeal. The present global industrial scenario is to produce quality

products at competitive price. This is possible with the increased productivity aimed at zero error.
In this paper the analysis of tool life in face serration operation is done. For making face serration a form tool is used.

LITERATURE REVIEW

From a process automation point of view, it is therefore necessary that an intelligent sensing system be devised to detect the progress of tool wear during cutting operations so that worn tools can be identified and replaced in time.[1]
Tool wear monitoring is important in machining industries for controlling the quality of machined parts that helps to improve the productivity. Today, many monitoring system methods are developed by utilizing various signals, and cutting force is one of the signals in machining process that has been widely used for tool wear monitoring. This paper presents the application of I-kaz based method to analyze the cutting force signal for monitoring the status of tool wear in turning process. Experiments were carried out by turning hardened carbon steel, and cutting force signals were measured by two channels of strain gauges that were mounted on the surface of tool holder. Results reveal that feed force is very significant due to flank wear, and I-kaz 2D is suitable to visualize any changes in the signals.[3]
Evaluation of the cutting tool is an important aspect when a machining process is monitored. At this time, micro-geometry of the cutting edge is very frequently used term. It has a great influence on the cutting process and it is necessary to know how correctly to measure parameters of the cutting edge to ensure reliability and repeatability. Nowadays, many devices exist on the market which can be used for measuring the cutting edge. They are based on tactile or optical principles. Parameters of the cutting edge have a great influence on tool life and therefore it is important to measure them correctly. Primarily the radius of the cutting edge and the K factor is usually monitored. Also measurement of roughness of the surface, chipping, and their evaluation is equally important.[8]
Tool degradation appears under various wear modes and mechanisms, such as flank wear and crater development. The various wear mechanisms essentially depend on the cutting conditions and on the tool and part materials. They can generate different statistical distributions of the operating time to failure such as the normal, the log-normal or the Weibull distributions. To evaluate the reliability of cutting tools in both variable and constant feed machining process, a mathematical model based on the theory of probability is necessary. This stochastic model is related to the random variable associated with the operating time to failure of the cutting tool. Typically tool failure modes are dictated by the following types of wear mechanisms

- Gradual wear (flank and nose wear), observed at low feed, speed, and depth of cut
- For higher values of depth of cut, the dominant failure mechanism is the depth of cut notch on the tool rake and flank faces
- For high cutting speeds and relatively high feed speeds, catastrophic failure due to tool breakage occurs. The time and severity of tool breakage depends on the speed.
- In finishing processes, depth of cut notches and secondary grooves are the causes of tool failure since the former causes chipping of the tool and the latter spoils the quality of the work piece surface.

Chemical wear is also one of the main causes of tool failure. The adhered work piece material always removes small particles of the tool when it breaks away and causes tool chipping. [4]
The ability to generate a quality surface in an economic and reliable fashion is vital for the widespread application of micro-end milling. Such will require a thorough understanding of

the fundamentals mechanisms associated with surface generation in micro milling. There are number of phenomena that prevail in micro milling that are fundamentally different from macro milling and influence the underlying mechanisms of the surface generation process. Surface roughness is influenced by machining parameters, such as feed, cutting speed, depth of cut and difficult to control factors, such as non-homogeneity of work-piece and tool, tool wear, machine motion error, formation of chips and unpredictable random disturbances. It has been shown that both controlled and non-controlled parameters cause relative vibrations between the cutting tool and the work-piece [6]
When the spindle speed is increased, the chip load decreases with maximally. Surface finish is degraded by 10 to 20 % with increase in cutting speed at constant depth of cut. At high chip loads, the contribution of cutting speed was 30 to 40 % in surface generation which is considerably more prominent factor. The relationship between chip load and surface roughness appears slightly non-linear, particularly at high cutting speed. [6]

EXPERIMENT DETAIL

For analysis of tool life in face serration operation for the connector used for cable housing which are manufactured in the Amphenol India. For this the experimental setup used is discussed as below. :

WORK PIECE

The connector parts like cable housing or back shell are having 100 degree of V- type face serrations on the face. The part name as cable housing & part no.-108885 selected for doing face serration & the suitable size of material of Ø 35 mm & of 800 in length is used The component will have the 36 numbers of serration on its face. The Component is shown in figure 1.

Figure 1: Cable Housing have face serration

The material of the cable housing or back shell will be Aluminium -6061 T6 grade whose chemical composition is shown in table 2.

Table 2. Chemical Composition of Material used for cable housing.

Silicon	0.4 to 0.8
Iron	0.7 max
Copper	0.15 to 0.4
Manganese	0.15 max
Magnesium	0.8 to 1.2
Chromium	0.04 to 0.35
Zinc	0.25 max
Titanium	0.15 max
Aluminium	Balance

MACHINE TOOL

The Mazak Japan make 3-axis Turn mill centre CNC machine used to do this operation. The capacity and other details of machines are as given in the table 1.

Table 1. CNC Machine Capacity

MACHINE MODEL	MAZAK-QTN 200-II M
Maximum machining diameter	350 mm
Maximum Bar work capacity	65 mm
3-Jaw hyd. chuck size	8” (8 inch)
Maximum spindle RPM	5000
Indexiable Turret	12 station
Main spindle Motor	22 KW (30HP)
Rapid traverse rate X-axis	30000 mm/min
Rapid traverse rate Z-axis	33000 mm/min
C-Axis with spindle	360°
C-Axis minimum command	0.001°

CUTTING TOOL

V-Type of Form Tool of 100° profile is used to make the serration on the face of cable housing.

The tool is made up of High Speed Steel having the chemical composition of the tool material is as below:

Carbon (C):1.1 %;	Chromium (Cr)-3.75%;	Molybdenum(Mo)-9.5%
Tungsten (W)-1.5%;	Vanadium-1.15%;	Cobalt (Co)-8.0%

Form type profile cutter is shown in figure 2.

Figure 2: Form type profile cutter.

EXPERIMENTAL SET UP

The cutting parameters for the face serration operation are selected on the basis of previous experience in the range shown in Table. 3.

Table 3: Process parameter doe face serration operation.

Level	1	2	3
Cutter Speed (r.p.m)	1000	1500	2000
Feed (mm/rev)	0.1	0.15	0.2
Depth of Cut (mm)	0.4	0.4	0.4

The material inserted in machine spindle & clamped in 3-Jaw chuck. Then the machining is started for part no-108885(Cable housing) & after completing all turning operations .i.e. outer, inner, threading, grooving. Then the face serrations of V-type of 100° done by V-type of form tool of having same 100° profile. The machine is having 3rd axis as C-Rotary with main spindle, which is having 360° of rotation & minimum indexing of 0.001° degrees. So to do these 36 numbers of serration, the 3-jaw chuck is indexed & clamped for every 10° for each serration by means of disk brakes. While doing serrations the chuck is clamped firmly & then V-type of form cutter starts machining & does 36 numbers of serrations on component.

In this work an attempt is made to evaluate the tool life and corresponding process parameter in face serration operation only. For this as we have finalised that there are the parameters like speed, feed and constant depth of cut. For obtain the data of tool life experiments are designed by using L9 orthogonal array. The sequence of operation and the tool life observed in each operation is recorded in table4.

Table 4. Experimental run and observed tool life

Sr. No.	Speed (r.p.m)	Feed (mm/rev)	Depth Of Cut (mm)	Tool Life (component/tool)
1	1000	0.1	0.4	503
2	1000	0.15	0.4	475
3	1000	0.2	0.4	458
4	1500	0.1	0.4	464
5	1500	0.15	0.4	455
6	1500	0.2	0.4	439
7	2000	0.1	0.4	425
8	2000	0.15	0.4	402
9	2000	0.2	0.4	379

The analysis of variance test on the above record is taken in MINITAB-16. The anova table recorded is shown in table 6.

Table 6 ANOVA table for tool life

Source	DF	SS	MS	F	P
Speed	2	9121	4560	11.35	0.009
Feed	2	2244	1122	0.72	0.523

RESULT DISCUSSION

The tool life recorded in the table will show that the increase in cutting speed and feed reduces the tool life. From ANOVAA table also it confirms the historical truth that the speed is only significant factor in tool life analysis. It is observed that the considerable number of reduction in component produced per tool when we increase the speed. Less variation is observed in number of components reduced per tool by increasing the feed only.
Cycle time is drastically affected by reducing the cutting speed and feed for increasing the tool life. Hence productivity is reduced drastically which influences in the increase in cost per component.

CONCLUSION

From the experimental record we are up to the conclusion that :

- The speed is most significant factor in tool life analysis.
- It is very difficult task to maintain the productivity at minimum cost per component by using form tool.
- We suggest that there is need of drastic change in tool design to improve productivity and ultimately reduced cost per piece.

ACKNOWLEDGEMENT

The authors would like to give wholehearted thanks to the dignitaries of Amphenol India who had permitted us to do our research work in their unit. We also thankful to all those who had given the required guidance and support in our work.

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