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Effects on Tool Chip Interface Temperature in Shaping Operation

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ABSTRACT

In this paper, the effect of tool rake, tool shape, tool radius and tool material on the tool chip interface temperatures was investigated when machining mild steel workpiece material. The machining tests were carried out on a shaper. For temperature measurement, a test setup that was designed and constructed for temperature measurement was used. The LM 35 types sensor were used to construct the setup and cutting temperature measurement readings were recorded on a computer during the tests. The MINITAB15 software is used to draw main effect plots and interaction plots between parameters. The effect of process parameters like feed, cutting speed, depth of cut, tool material, and tool shape and tool geometry is seen on the tool chip interface temperature.

Key words: chip interface temperature, shaping operation

INTRODUCTION

In metal cutting, a cutting tool is used to remove excess material from a workpiece in order to convert the remaining material into the desired part shape. Proper selection of tool materials, cutting parameters, tool geometry and machine tools are essential to produce high-quality products at low cost. Therefore, many attempts have been made to reduce cost and improve quality through the understanding of the cutting process. A considerable amount of these investigations has been directed towards the measurement and prediction of the temperature during machining. That is because, knowledge of the tool chip interface temperature is important as they have a direct influence on the generation of heat, and thus on tool wear, quality of machined surface and accuracy of workpiece. They are also used in the design of machine tools, cutting tools and fixtures [2-4].

In the literature, there are many studies concerning the temperature measurement. Many techniques have been developed for this purpose. However, these are mainly for turning and milling operations. No work dealing with the measurement of the temperature during machining with linear motion as in shaping has been reported in the literature. Although shaping is one of the oldest single-point machining processes and it has largely been replaced by milling and broaching, it may be still important in examining the effect on temperature during shaping operation is in different manner in compare to turning operation. In this study, in order to investigate the effect of cutting parameter, tool shape, tool geometry ,tool material on tool chip interface temperature during the machining with linear motion a test setup has been designed and manufactured [13-16].

LM 35 sensor used in this setup and the tool chip interface temperature values were recorded automatically on a computer during the tests. LM 35 sensor is highly precise sensor. The accuracy of LM 35 is 0.8 °C. There is no environmental effect on LM 35. Analyses have been done by using MINITAB 15 software to draw main effect plots and interaction plots between parameter. Although shaping is one of the oldest single-point machining process-es and it has largely been replaced by milling and broaching, it may be still important in examining the effect of cutting parameter on tool chip interface temperature because the results of cutting parameter on turning is not similar to shaping operation that's why thermal aspects in shaping operation is need to study. In this study, in order to investigate the effect of feed, speed, depth of cut, tool materials, tool geometry, tool shape on tool chip interface temperature during the machining with linear motion a test setup has been designed and manufactured [6-9]. LM 35 type temperature sensors were used in this setup and the temperature values were recorded automatically on a computer with the help of RS 232 data logger during the tests.

EXPERIMENTAL SET UP

In the experimental set up a dynamometer for measuring the cutting force & thrust force and temperature measuring set-up using LM 35 sensor is designed and developed. The beam type load cells were used to construct the setup and cutting force measurement readings and IC for temperature measurement were recorded on a computer with RS 232 data logger during the tests

Fig. 1 Position of Load Cell

Fig. 2 Experimental Set-Up

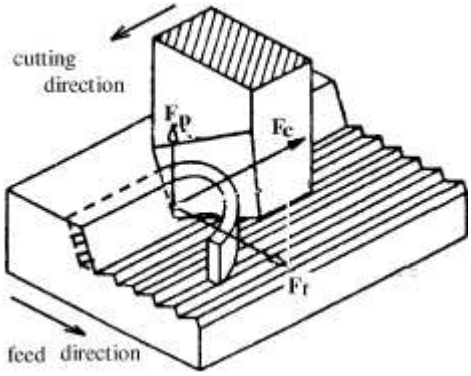

Fig. 3 Mechanism of Shaping Operation [17]

Fig. 4 Temperature Measuring Set Up

DIFFERENT TOOL USED FOR EXPERIMENTS

A Different shapes: V- shape, parting tool and curved shape.
B Different nose radius: 1 mm, 2mm and 4mm
C Different tool material: HSS, K20 and P30
D Different Rake angle: 0º, 3º and 5º.

Different Tool Shapes (1. V- Shape, 2. Parting And 3.Curved Shape, Material HSS)

Fig. 5 Different Tool Materials& Shapes

Table- 1Table for Run 1-8

Run	V(m/min)	f(mm/stroke)	d(mm)	Temperature
1	5.34	0.30	0.5	34.7
2	11.63	0.30	0.5	37.5
3	5.34	0.30	1.0	41.4
4	11.63	0.30	1.0	44
5	5.34	0.35	0.5	35.1
6	5.34	0.35	1.0	41.5
7	11.63	0.35	0.5	38.6
8	11.63	0.35	1.0	44.9

RESULTS&DISCUSSION

Main effect plots for Temperature for Run 1-8

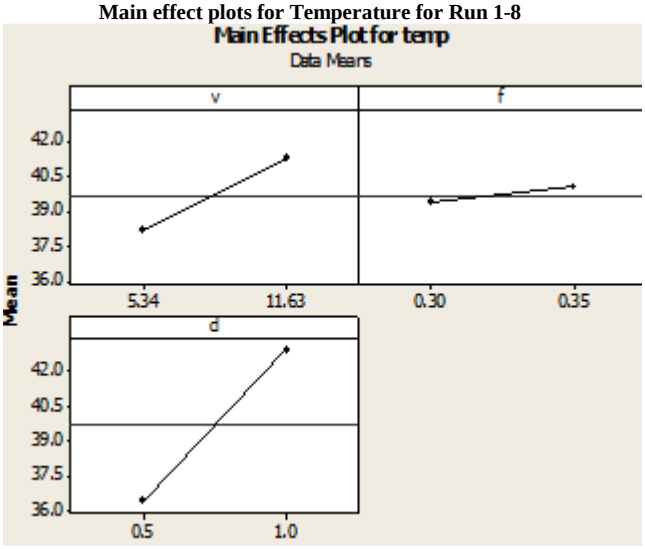

Fig. 6 Temperature Variation V/S Speed, Feed and Depth of Cut

Interaction plot for Temperature

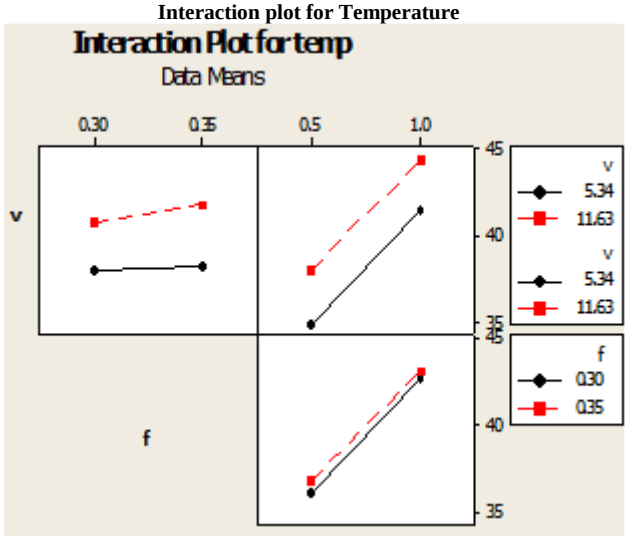

Fig. 7 Interaction Plot For Temperature

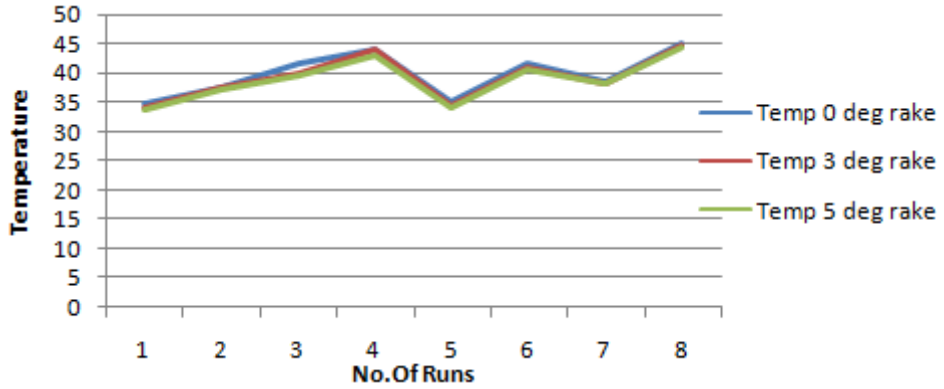

Fig. 8 Effect of Tool Rake on Temperature

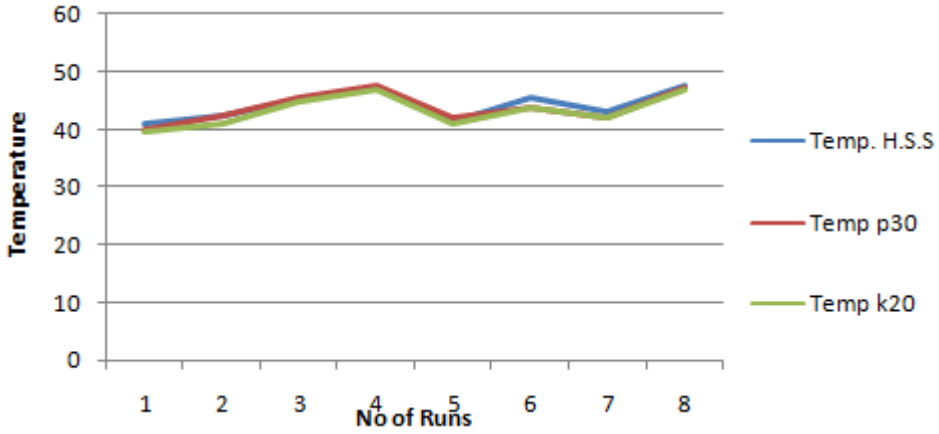

Fig. 9 Effect of Tool Material on Temperature

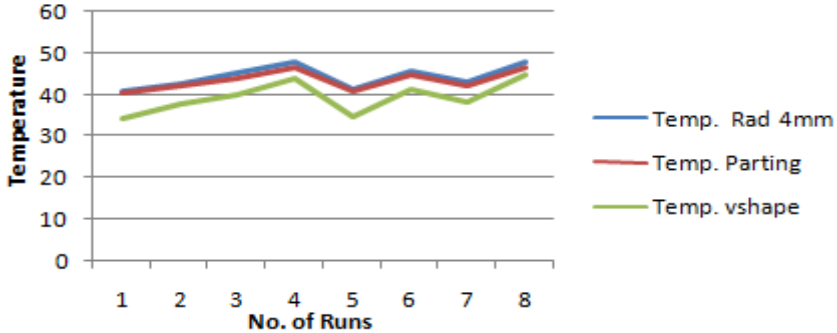

Fig. 10 Effect of Tool Shape on Temperature

CONCLUSION

By using the designed and constructed set up, the effects of cutting speed, feed, depth of cut, tool material, tool shapes, and tool geometry on temperature during machining these parts with linear motion can be evaluated. From the present work, following conclusion can be drawn:

- The temperature increased with increasing depth of cut followed by speed and feed decrease during shaping operation.
- The main effect of radius tool is more on temperature followed by parting tool and v shape tool.
- The main effect of tool material HSS is more on temperature followed by P30 and k 20 with tool radius 4mm i.e hardness of k20 is larger than P30 and HSS that's why the cutting temperature is very less with the K20.
- By increasing the rake angle the temperature are in decreasing manner its reduce the friction.
- By using the MINITAB 15 data were analyzed and draw the main effect plots and interaction effect between parameters. Analysis show that effect of depth of cut in more on temperature followed by speed and feed this result is different from turning. That's why effect of cutting parameter in shaping operation need to study.
- This system can be used reliably to measure temperature during shaping.

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