Scholars Journal of Engineering and Technology (SJET)
Abbreviated Key Title: Sch. J. Eng. Tech.
ISSN 2347-9523 (Print)
ISSN 2321-435X (Online)

A Unit of Scholars Academic and Scientific Society, India
www.saspublishers.com

The Effect of Cutting Fluid on Chip-Tool Interface Temperature While Turning AISI 4340 Steel

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Original Research Article

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Article History
Received: 20.01.2018
Accepted: 10.02.2018
Published: 15.02.2018

DOI:
10.36347/sjet.2018.v06i02.002

Abstract: The machining parameters of any machining operation highly affect the surface quality of a component. The objective of this paper is to study the effect of cutting fluid (SERVOCUT 'S' Grade oil emulsified with water) on chip-tool interface temperature while turning AISI 4340 cylindrical steel components. The turning operation was carried out with TiN coated carbide insert on the AISI 4340 steel under traditionally flooded condition. The turning parameters, namely cutting velocity, feed rate and depth of cut were chosen for the conduct of experiments. The chip-tool interface temperature of the turned specimens was measured using a properly calibrated K-type thermocouple.
Keywords: AISI 4340, TiN coated carbide insert, turning operation, flooded condition, chip-tool interface temperature.

INTRODUCTION

Machining is one of the most versatile manufacturing processes for producing desired shape and size of a component for the functional behaviour of any machine mechanism [1-3]. Manufacturing involves numerous processes to convert raw materials to finished products to be used for various purposes [3-4]. The poor surface quality fails to satisfy functional requirements of the products, while extremely high surface quality causes high production costs and low overall productivity. Hence, the improved surface quality and the economics of the manufacturing operation are becoming a very important consideration to produce the finished products [1-3, 5-6]. The cutting fluids are employed in machining to decrease friction, cool the job and wash away the chips.

With the application of cutting fluids, the wear rate of the tool gets reduced and surface quality of machined components gets improved. In addition, the cutting fluids protect the machined surface from the occurrence of corrosion. They also minimize the cutting forces thus saving the energy. Many researchers are working in the field of cutting fluids to reduce its usage while machining for environmental and economic benefits [7-11].

Tool wear can be minimized by employing lower values of cutting velocity, feed rate, depth of cut and machining time [12]. The machining power and cutting tool wear increase almost linearly with the increase of cutting speed and feed rate [13-14]. In high-speed machining of stainless steel using coated carbide tool, the feed rate is found to be more significant followed by the cutting speed and the depth of cut [15-18].

The researchers [19] studied the influence of turning parameters such as speed, feed rate, depth of cut and tool nose radius on the surface roughness of medium carbon steel and suggested optimized parametric setting for obtaining better surface finish and lesser heat at the machining zone.

From the literature survey, it becomes clear that the effect of cutting fluids in the field of machining carbon steels have been investigated by many researchers. Still, there remains some difficulty in the machining of carbon steel with the application of cutting fluids, which reveals that still more research has to be carried out to find a reasonable solution. Therefore, the turning operation was carried out on the AISI 4340 steel under flooded machining conditions in order to study the effect of cutting fluid on the chip-tool interface temperature of the turned specimens in this study.

Experimental conditions

- Workpiece used – AISI 4340 (Ø80mm x 150mm)
- Cutting tool used – TiN Coated carbide insert
- Machine tool – Turning centre (All Geared Conventional Lathe)
- Cutting fluid – Mineral based (Servocut ‘S’) emulsion
- Coolant application technique – flooded
- Output response – Chip-tool interface temperature

RESULTS AND DISCUSSION

The parameters namely cutting velocity (m/min), feed rate (mm/rev) and depth of cut (mm) were considered while turning of AISI 4340 steel under flood, near dry and dry machining conditions. The various levels of the parameters are given in Table 1.

Table-1: Parameters and their levels

Parameter	Notation	Levels		
		1	2	3
Cutting velocity (m/min)	v	325	350	375
Feed rate (mm/rev)	f	0.1	0.15	0.2
Depth of Cut (mm)	d	0.3	0.6	0.9

Effect of Parameters

The effect of cutting velocity was observed with a constant feed rate of 0.15 mm/rev and with a constant depth of cut of 0.6 mm while machining steel AISI 4340. It was observed from Figure 1, that the chip-tool interface temperature value increased drastically with the increase of cutting velocity.

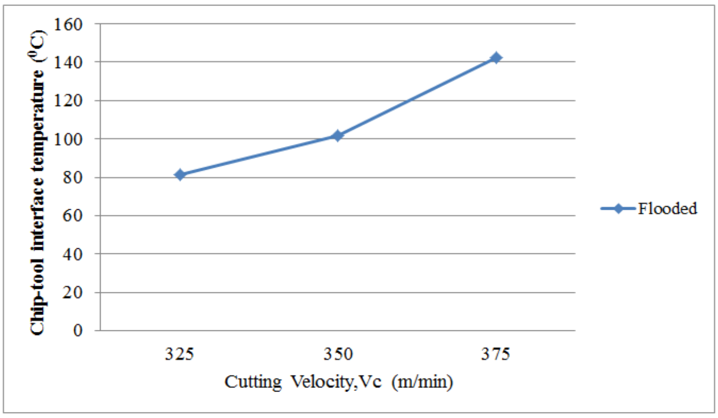

Fig-1: Effect of cutting velocity on chip-tool interface temperature

The effect of feed rate was observed with a constant cutting velocity of 350 m/min and with a constant depth of cut of 0.6 mm while machining steel AISI 4340. It was observed from Figure 2, that the chip-tool interface temperature value increased gradually with the increase of feed rate.

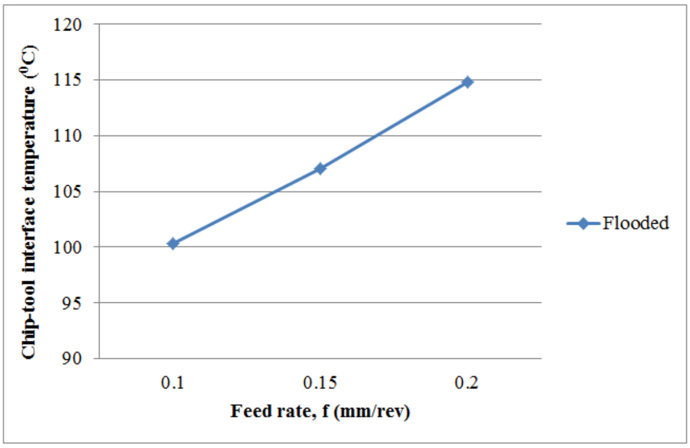

Fig-2: Effect of cutting feed on chip-tool interface temperature

The effect of depth of cut was studied with a constant cutting velocity of 350 m/min and with a constant feed rate of 0.15 mm/rev when machining steel AISI 4340. It was observed from Figure 3, that, the chip-tool interface temperature value increased gradually with the increase of depth of cut.

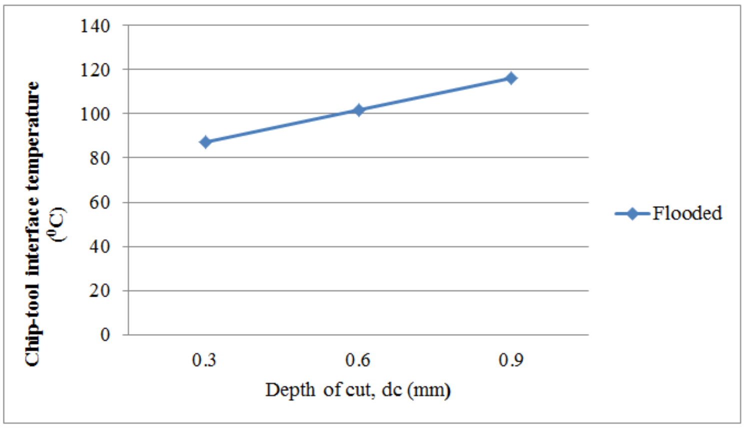

Fig-3: Effect of depth of cut on chip-tool interface temperature

Contribution of Parameters

The machining parameters were ranked based on the variation of their effect on the chip-tool interface temperature. The percentage contribution of machining parameters is shown in Figure 4.

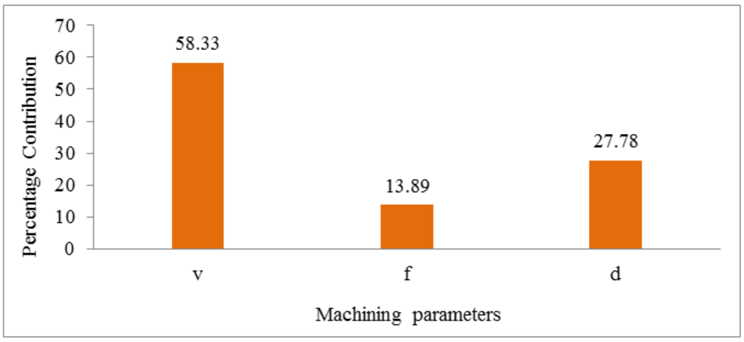

Fig-4: Percentage contribution

CONCLUSION

Based on the chip-tool interface temperature test conducted on AISI 4340 steel during turning operation with titanium nitride coated carbide insert under flooded machining condition, this research work is concluded with the following key points:

- From the effect curve plotted for cutting velocity, it was evident, that the chip-tool interface temperature value increased drastically with the increase of cutting velocity.
- From the effect curve plotted for feed rate, it was evident, that the chip-tool interface temperature value increased gradually with the increase of feed rate.
- From the effect curve plotted for depth of cut, it was evident, that the chip-tool interface temperature value increased gradually with the increase of depth of cut.
- From the experimentation, it could be concluded that cutting velocity has a greater effect on the chip-tool interface temperature followed by the depth of cut and feed rate, which is shown in the contribution chart (Figure 4).

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