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Experimental investigation of the infeed method and machining parameters on the tool wear during thread milling

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ABSTRACT: Thread has been considered a widely used technology in industries. Thread milling is suggested as an alternative process of tapping. Thread milling includes a small tool that follows a helical path. This process includes significant advantages such as threading holes with different diameters using a specific tool. One of the important issues in machining is tool wear. In thread milling, effective parameters on the tool wear include tool angles and geometry, infeed method, feed, and tool rotational speed. Tool wear and infeed method in thread milling have not been addressed in recent investigations. Hence, this research studies the infeed methods and effective parameters of the machining process on the tool wear during thread milling. Experimental results showed that increasing feed from 0.2 to 0.4 mm/rev led to 30% to 40% larger values of flank wear. Also, the variation of rotational speed from 500 to 900 rpm increased the flank wear about 50% to 60%. Two cases of incremental and modified flank infeed were employed. Considering different rotational speeds, the incremental infeed method increased the tool life about 100%, while the modified flank infeed method achieved 300% higher tool life. During the incremental infeed method, the tool-workpiece engagement area was distributed between two curring edges and reduced adhesion and diffusion mechanisms of tool wear, which finally resulted in significant tool life.

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1. INTRODUCTION

Thread is one of the technologies widely used in the industry. Internal thread processing methods include thread-turning, tapping, and thread milling. Thread milling is suggested as one of the alternative methods of tapping. In this method, a tool with a smaller diameter moves in a spiral direction to fabricate the thread. Thread milling is shown in Fig. 1. This type of operation consists of three movement directions: the tool axis, off-center movement (the spiral movement), and feed forward.

The effective parameters on threading milling are tool angles and geometries, feed, infeed methods, tool diameter, rotational speed, and thread pitch [1, 2].

One of the important issues in machining is tool wear. The tool wear has a direct impact on the surface smoothness and dimensional accuracy of the machined workpiece. In high accuracy cases, the wear of the tool should be limited to the extent permitted [3]. In recent years, the focus of studies and articles on thread milling has been more on the forces applied to the tool and the modeling of forces [4-6].

Hence, in this study, the influence of machining parameters (rotational speed and feed rate) on thread milling of gray cast iron is discussed. Also, different infeed methods of thread milling have been attempted and achieved values of tool wear have been compared.

2. MATERIAL AND METHODS

Due to the nature of the thread milling process that needed CNC programming, a CNC milling machine was used. Fig. 1 shows schematic and actual views of the thread milling.

An employed tool is a single-edge tool. The workpiece material is gray cast iron. Considering the characteristics of the thread (M30 x 1.5), holes were fabricated with a diameter of 27.5 mm and a depth of 24 mm. A Dino-LiteAM-413ZT microscope was used to measure the tool wear.

Due to software limitations, the G-coding was performed manually, using the G02 code. The experimental parameters and levels are shown in Table 1. According to the tool diameter, the cutting speed besides related rotational speed is also reported.

3. Results And Discussion

After each experiment, the tool flank wear was measured by the microscope. For example, tool wear images at N=700 rpm and f=0.3 mm/rev are reported in Fig. 3. The diagrams of tool wear for different infeed methods are shown in Fig. 4, using the spindle speed of 700 rpm and feed of 0.4 mm/min.

As shown in Fig. 4, the incremental depth method has the least tool wear, followed by the 28° lateral depth method. In incremental infeed method, cutting edge changes for every cutting pass in such a way that each edge is used for half of the machining passes. The distribution of tool-workpiece

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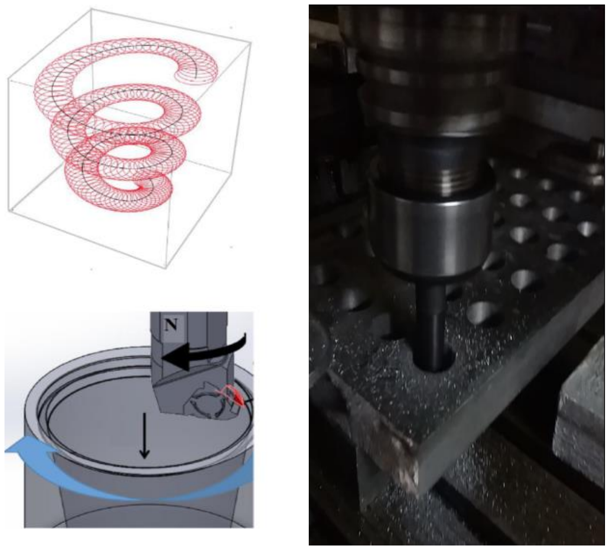

Fig. 1. Schematic and actual views of thread milling

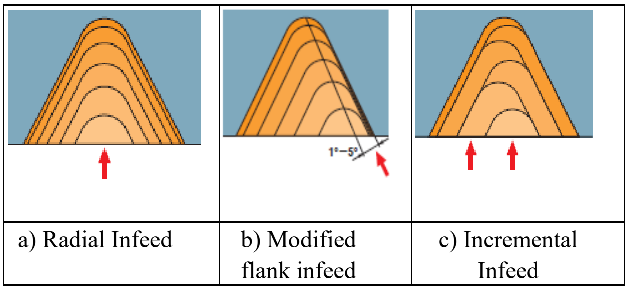

Fig.2 . Infeed methods in thread cutting

Table 1. Design of Experiments

	Machining parameters	Level 1	Level 2	Level 3
1	Spindle speed (rpm)	500	700	900
	Cutting speed (m/min)	(26)	(37)	(48)
2	Feed (mm/rev)	0.2	0.3	0.4
3	Infeed method	Radial infeed	Modified flank infeed	Incremental infeed

engagement, between two cutting edges, leads to a reduction of the mechanical wear on the cutting edges.

Also, because the heat generated is distributed on both sides of the rim, the surface temperature is lower than the direct depth method, which reduces the adhesion wear. Also, in the 28° lateral depth method, one side of the edge has no impact on the workpiece, so the slighter force is applied to the tool, which reduces the mechanical wear and temperature of the workpiece in the direct depth method. In the direct depth method, the entire edge of the tool is in contact with the workpiece, which results in greater friction and higher force. Also, the contact temperature is higher than the other methods, which increases wear compared to other strategies.

4. CONCLUSIONS

The main results are described as follows:

a. Increasing the feed led to higher tool wear. By increasing the feed from 0.2 to 0.4 mm/rev, the tool flank wear increased by 30 to 40%. Also, increasing the spindle speed from 500 to 900 rpm, at different feeds, obtained 50 to 60% higher values of tool flank wear.

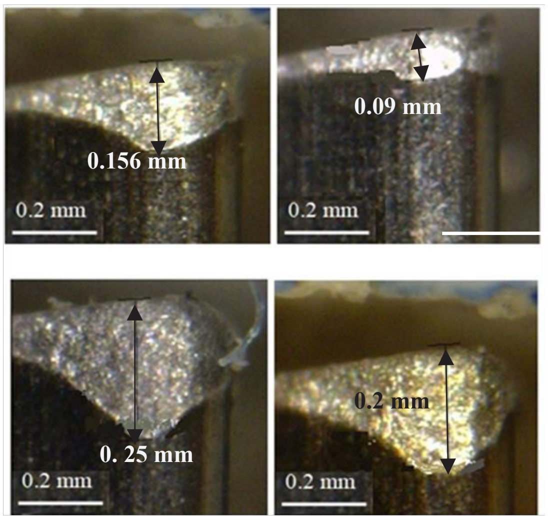

Fig.3 . The images of tool wear in the radial infeed method

b. Incremental infeed method and modified flank infeed increased the tool life by 300% and 100%, respectively.

c. The incremental infeed method has the least values of tool wear among the three infeed methods. In incremental infeed method, each edge is used for half of the machining passes. Hence, tool-workpiece engagement was distributed between two cutting edges, which generated lower temperatures on every edge and totally, resulted in a reduction of tool wear.

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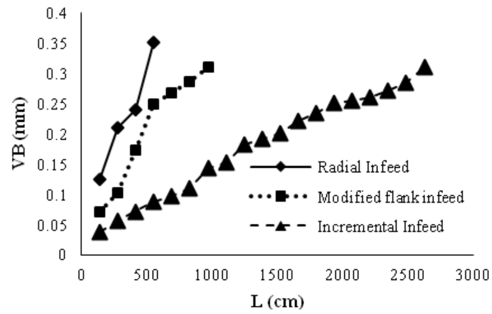

Fig. 4. Dependence of the tool wear to the length of cutting, using *N*=700 rpm and *f*=0.4 mm/rev

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