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Optimization on the Effect of Nozzle Orifice Coolant Supply during Machining Automotive Material Al319

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Abstract. The thermal effect of the adhesive material of Aluminum Alloy 319 (Al319) on the cutting tool (insert) causes major problems in surface roughness, tool wear, as well as temperature due to the tendency to melt during the cutting process which can lead to the formation of formed edges, inaccuracies of measurement on the workpiece, surface damaged due to oxidation, which can reduce the life of the insert. The objective of this research is to optimize the nozzle cooling system method in the machining performance of Aluminum alloy 319 to achieve good surface roughness, low-temperature reading, and less insert wear by selecting machining parameters appropriate to cutting speed, cutting depth, and feed rate. The variety of orifice nozzle measurements used from nozzles 1.0 mm to 5.0 mm with the use of different machining parameters (cutting and spindle speed and with fixed cutting depth) using on CNC lathe condition. This method is done by the basic reaction surface (RSM), which is one of the alternative methods to minimize the cutting process that can be done at high cutting speed in which the temperature can minimize the formation of wear on the insert. Built-in edges and thermal construction can reduce the roughness of the work surface. The results of this research the smallest orifice nozzle used able to minimize the thermal impact and reduce the temperature that causes the arrangement of lower build edges (BUE). Therefore, better surface roughness, minimum insert use as well as low temperatures can be achieved. This is because the direction of the coolant can be directed at a point that can remove heat from the chips. The use of cutting fluid from the smallest nozzle size and technical conditions in the machining process can also be offered to obtain productivity, high-quality products, lower costs as well as minimize environmental impact (refrigerant waste is generated). This research is very useful to minimize the cost of the machining process budget and also increase productivity in the machining industry and can also decrease the dependency of machine operators on the skills and knowledge available.

1. Introduction

Usually, for machining, the choice of cutting parameters is left to the machine operator. In such a way, the involvement of operating a machine plays a key role, but indeed for a competent operator, also it is still difficult to achieve the best parameter values in a single operation. In the machining industry, the practice of using conservative cutting conditions based on handbooks is at the planning stage. A drop in productivity due to the less efficient use of machine capacities is the downside of this unscientific procedure [1]. The current optimization research on CNC rotation is imitated in its specific



manufacturing conditions. The choice of cutting conditions for the machining process has historically been left to the machine operator [2]. In such situations, the operator's expertise plays a major role, but it is very difficult, even for a professional operator, to obtain the ideal value each time. In Industries machining are dependent on the experiment and the skill of the machine tool operating for the optimal selection of cutting conditions. In the machining industry, the tradition of using conservative cutting conditions based on handbooks is at the planning stage. The downside to this unscientific method is that efficiency drops due to the sub-optimal usage of machining capacities [3]. The current optimization research on CNC turning is simulated within its particular manufacturing circumstances [4]. Today the challenges of the modern machining industry are mainly focused on achieving high quality in terms of workmanship dimensional accuracy, flat and neat surface rate, high production rate, less cutting tools, machining economy in terms of cost savings, improved product performance with reduced environmental impact [5]. The quality characteristics of machine parts are calculated by the setting of these parameters. This chapter provides a brief description of the project background, including a new approach to measurement nozzle variations. Because of its high removal rate and efficiency, the introduction of a new approach to designing variance measurement nozzles is one of the most important areas of research. Most CNC turning machines are fitted with a kind of flood coolant, soluble oil. There is currently a study of nozzle designs available and an overview of the suitability of each are provided for various applications. This research uses the fundamental RSM method (DOE) in studying the effect of rotational parameters on the roughness of the rotating surface. A quality management technique that integrates control and process control charts with the product and process design to achieve a comprehensive total design is the basic RSM analysis system approach. Thanks to its lightweight and strong mechanical properties, Aluminum Alloy 319 has become the tool and instrument of choice for automotive parts, providing a stronger strength-to-weight ratio of materials. For structural applications including such cylinder head parts, it is frequently used. It also has excellent casting properties and good mechanical properties [6]. Aluminum Alloy 319 is a precipitation hardening material, which contains magnesium and silicon as its main alloying elements. It has excellent mechanical properties and demonstrates good potential for classification. Aluminum is among the most common Aluminum items for regular use. Aluminum Alloy 319 mechanical properties are strongly temperature-dependent or heat of the material, leading to widespread use in the design of aircraft structures, such as wings and aircraft, which are most widely found in domestic aircraft rather than military and commercial aircraft. It is also used for the structure of yachts, including little utility ships. During the cutting tool operation, most researchers concentrate on cutting speed, feed rate, cutting depth. In this research, there is research on the influence of the flow hole cooling nozzle cooling system available on the range of rotational operating parameters on Aluminum Alloy 319. The effectiveness of variation orifice cooling nozzle is evaluated in terms of thermal usage, temperature, and surface roughness.

2. Methodology

2.1. Experimentation investigations

This experiment was performed on a 2-axis CNC Lathe machine (Puma 230) to study the diameter of the nozzle orifice for the cooling technique used in this research which will produce better cutting performance such as cutting temperature. The experimental preparation is shown in Figure 1. Nozzle variation nozzles during rotary operation are very important for the rotation process, the surface of which is produced should be investigated in terms of surface roughness, tool wear, and temperature. Nozzle holes vary to different cutting speeds and different bait rates for each cutting process are used according to the experimental work arrangement. New inserts are replaced for each piece of the workpiece.

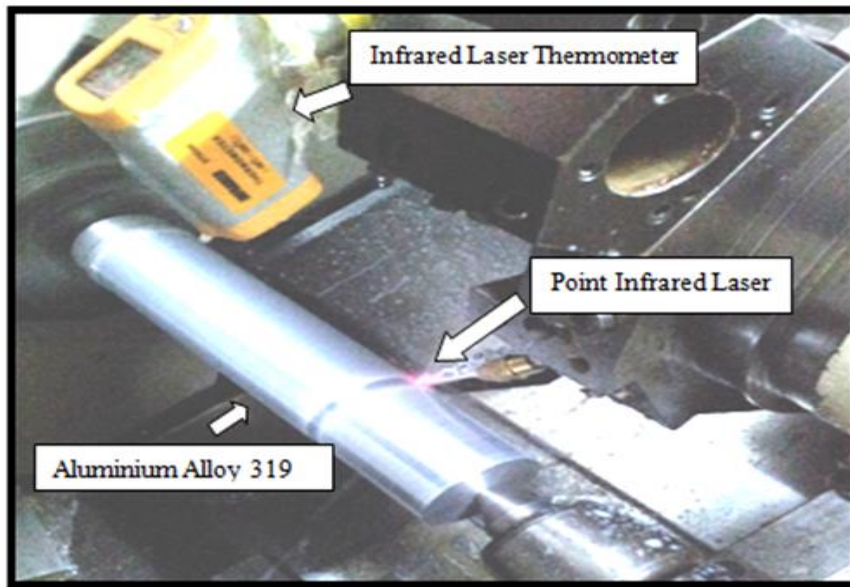


Figure 1. The experimental setup

2.2. Material and Cutting Tool

The cutting material used for this experiment is Al_2O_3 coated cemented carbide, which is an alumina layer with a thin layer of high temperature, durable and hard constituents that spread to the surface of ordinary cement carbide. The cutting tool model used is VCGT 160404 TH K10 produced by Ecodex. This insert is used because of its durability, high performance, and prevalence in the industry

3. Results and Discussion

The results about this experiment appear that as the cutting speed increments, the wear of the instrument increase quickly, and the size of the cooling spout will increase also followed by the wear of the wing increase. This issue is due to the high temperature delivered within the cutting zone where an effective cooling framework system is required to cool the machining area between the work piece and the end of the tools [7].

Instrument wear is measured by using a Maker Tool Microscope with a 10X amplification at 15-minute interims. The experimental data appear that the utilize of the tools on the wings dominates the quality of surface roughness amid machining of combinations of AI 319 and AL_2O_3 coated carbide inserts.

Figure 2 shows the tool wear rate at diverse cutting speeds with the cooling nozzle measurement and size. The result gotten from instrument flank wear measurement rise above the maximum limit international guidelines. The date from this experiment shows that the application of the tools increments quickly with the cutting speed and the wear of the wing increments with the size of the cooling nozzle.

The phenomenon causes by the high temperature were produced in the cutting area. An effective cooling system is required to cool the machining operation between the ends of the tools and the work piece [8]. This ultimately enhances the cooling effect and reduces the temperature and grinding between the tool and the workpiece [9].

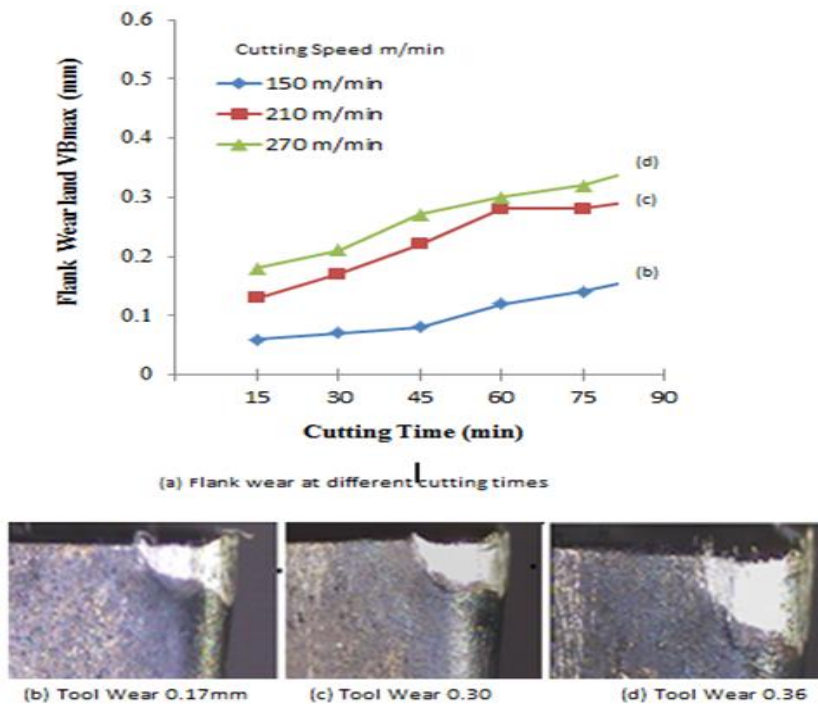


Figure 2. Impact of flank wear at diverse cutting times following by differ of cutting speeds at coolant nozzle size of 1.0 mm

Figure 3 shows that the condition of flank wear rise as the cutting and cutting speed raised. The flank wear rate rise from 0.17mm at the cutting speed of 150m/min to 0.36mm at the cutting speed of 270m/min. By using the cutting speed at 150m/min with a cooling nozzle with size of 1.0mm gives a minimum flank wear rate and at the same time it will reduces the temperature in the cutting area and moderates down the chip accumulation process [10]. In fact, a minimum flank wear can be gotten by using a cooling nozzle measuring 1.0mm. From the figure below, we can see that the flank wear expanded from 0.27mm at the cutting speed 150m/min to 0.42 mm at the cutting speed of 270m/min. While by using the cutting speed of 150m/min will gives a minimum flank at rate of cooling nozzle at size 2.0mm.

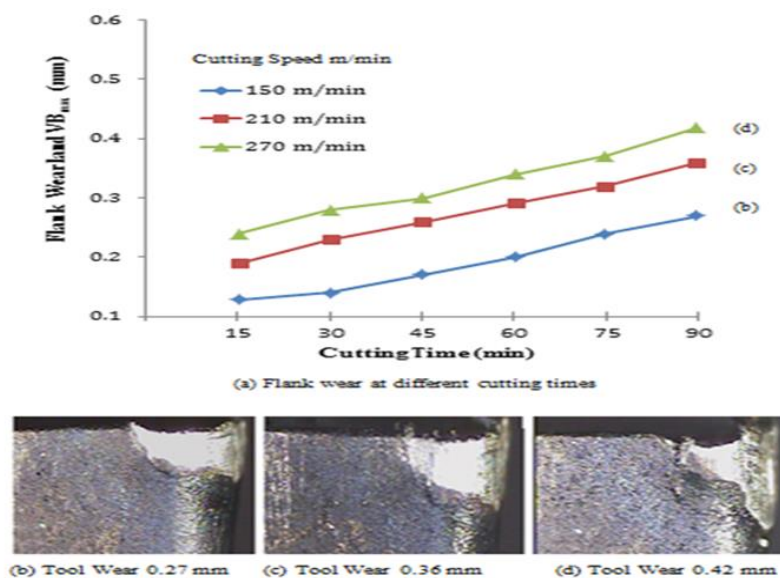


Figure 3. Effect of flank wear with different cutting times for different cutting speeds at a nozzle size of 2.0 mm

Figure 4 shows that the flank wear will increase from 0.40 mm at the cutting speed of 150 m / min to 0.49 mm at the cutting speed of 270 m / min if by using a cutting speed of 150 m / min with a cooling nozzle size 4.0 mm give minimum flank wear rate

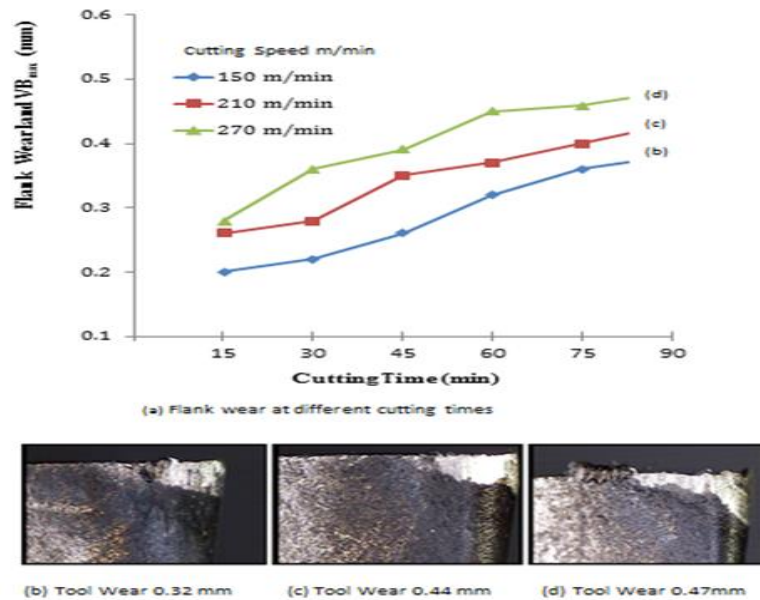


Figure 4. Effect of flank wear at different cutting times for different cutting speeds at a nozzle size of 3.0 mm

Figure 5 shows that the flank wears will increase from 0.40 mm at the cutting speed of 150 m / min to 0.49 mm at the cutting speed of 270 m / min if by using a cutting speed of 150 m / min with a cooling nozzle size 4.0 mm gives minimum flank wear rate.

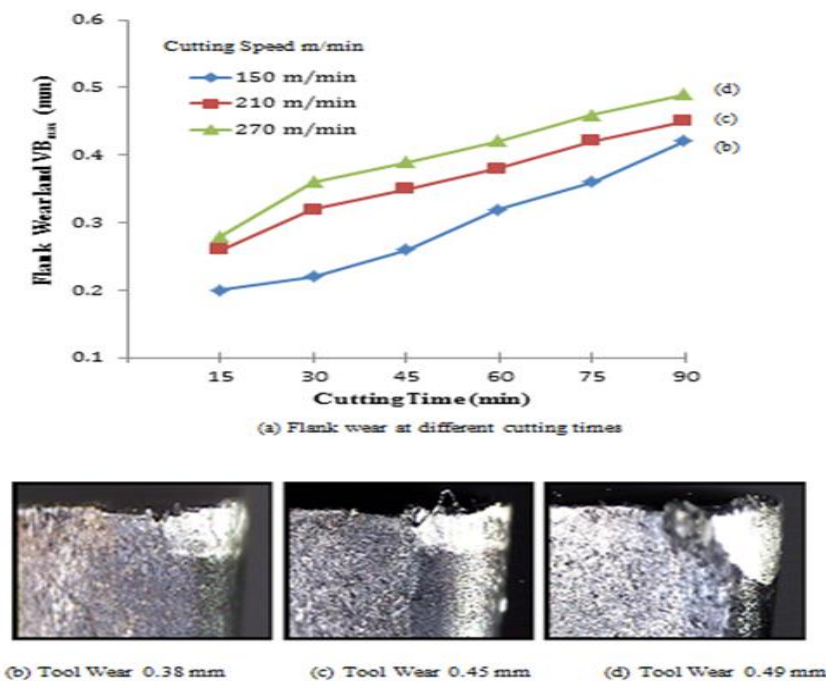


Figure 5. Effect of flank wear at different cutting times for different cutting speeds at a nozzle size of 4.0 mm

Figure 6 shows that flank wear will increase from 0.42 mm at a cutting speed of 150 m/min to 0.54 mm at a cutting speed of 270 m/min if by using a cutting speed of 150 m/min with a coolant nozzle size of 5.0 mm gives a minimum flank wear rate.

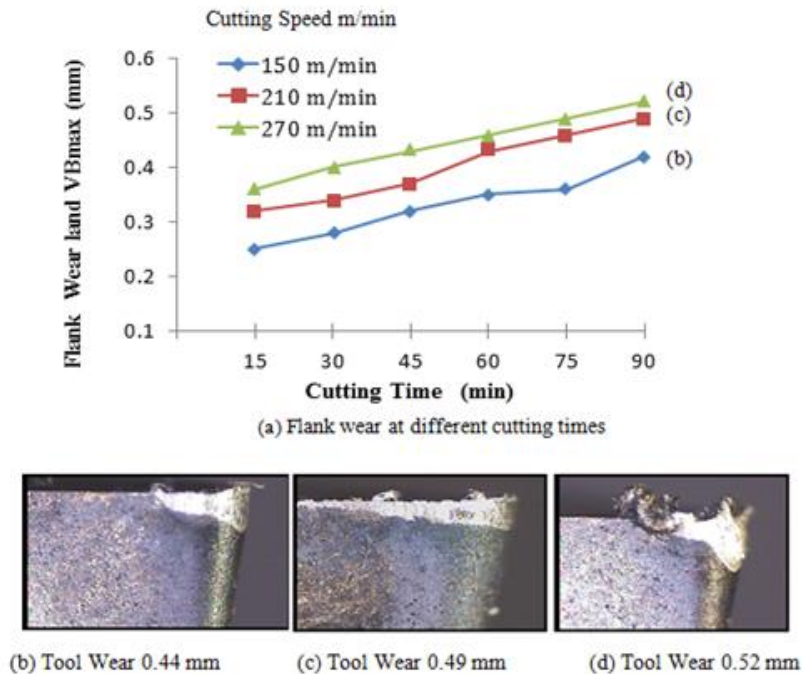


Figure 6. Effect of flank wear at different cutting times for different cutting speeds at a nozzle size of 5.0 mm

Based on Figure 2 to Figure 6, we can conclude that the graph shows that the wear of the flank increases as the cutting time and the cutting speed increase. This phenomenon is due to the high temperature were produced in the cutting area and the chips were exists into the inserts [11]. To reduce the wear rate of the flank, the temperature should be reduced by using an effective cooling system. Therefore, from this experiment by using a cooling nozzle measuring 1.0 mm and cutting speed of 150 m / min can reduce the temperature in the cutting area and slow down the process of chip build-up accumulation. Therefore, minimum flank wear can be obtained by using a cooling nozzle measuring 1.0 mm.

The use of a controlled measuring device controls the surface roughness quality during Al alloy machining with Al_2O_3 -coated carbide inserts. Figure 7 shows a tool life graph versus machine length, using standard tool life criteria $\text{VB}_{\text{max}} = 0.5$ mm with cutting speed of 150 m / min. This can be seen in the long-term effect of machining time on the lifespan of tools with different cooling nozzle sizes. From the graph where the machining length varies, it is expected that the decrease in cooling nozzle size will cause a positive effect on the life of the tool and prevent the impact of surface roughness from increasing. Therefore, it can be concluded that with a cutting speed of 150 m / min, the life span of the tool is at a minimum value. The best results were achieved in this research when using a cooling nozzle measuring 1.0 mm at a machining length of 300 mm.

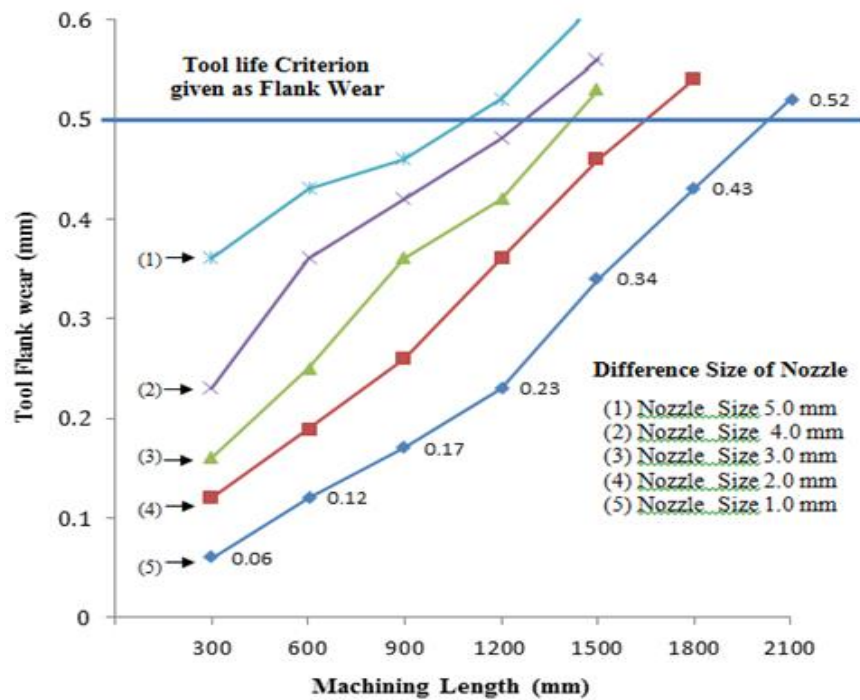


Figure 7. Effect of machining time length on cutting speed at different machining lengths

4. Conclusion

Conclusions based on the results of this study were found for the use of Al 319 alloy tool with Al_2O_3 coated carbide inserts using various cooling nozzle holes measuring 1.0 mm, 2.0 mm, 3.0 mm, 4.0 mm, and 5.0 mm. The analysis shows from Figure 6 shows that by using a cooling nozzle hole measuring 1.0 mm, the surface roughness cutting speed of 150 m / min has the lowest value of $0.53\mu m$. The maximum readings for Ra to be reversed are Rough Grade number (N6) Ra value $0.8\mu m$ to Rough Grade number (N9) Ra value $6.3\mu m$ [12]. The cooling nozzle size of 1.0 mm shows the wear of the tool decreasing at a low value of 0.27 mm with a cutting speed of 150 m / min. At a cutting speed of 150 m / min, a 1.0 mm temperature coolant nozzle measurement is produced at a minimum temperature of $74^\circ C$. Therefore, it is concluded that at a cutting speed of 150 m / min and a 1.0 mm cooling nozzle measurement gives optimal results in terms of surface roughness, temperature, and tool wear and tool life during machining with Al 319 alloy.

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