CUTTING PERFORMANCE IN GROOVING TURNING OF SUPER HEAT-RESISTANT ALLOY INCONEL 718 WITH A HIGH-PRESSURE COOLANT SUPPLY

Tadahiro WADA

International Journal of Mechanical and Production Engineering, ISSN(p): 2320-2092, ISSN(e): 2321-2071
Volume- 7, Issue-11, Nov.-2019, http://iraj.in, pp. 42-46.
(Proceedings of ISER 220th International Conference, Bangkok, Thailand, 21st-22nd August 2019)

INTRODUCTION

Hickel-based alloys such as Inconel 718 are difficult to cut due to their outstanding mechanical properties [1]. A major requirement of cutting tool materials used for machining nickel-based alloys is that they must possess adequate hot hardness to withstand elevated temperatures generated under high-speed conditions during machining. Most cutting tool materials lose their hardness at elevated temperatures resulting in weakening of the inter-particle bond strength and consequent acceleration of tool wear [2]. Therefore, in the cutting of a nickel based-alloy, due to the high cutting temperature and strong adhesion generated at the interface between the cutting tool and the chip, the wear of the tool becomes large. Thus, when cutting nickel-based alloys, a slower cutting rate is required than when cutting carbon steel.

High-speed cutting is desirable to improve productivity, however in high-speed cutting the rise in cutting temperature is significant. In particular, when cutting nickel-based alloys the cutting temperature rises rapidly, so the tool material must have both excellent wear resistance and heat resistance. Wet cutting is effective for cooling and cooling of tools.

High-pressure coolant cutting is effective for lowering the cutting temperature and reducing the tool wear [3-6]. By supplying high-pressure coolant into the cutting edge, the cutting temperature decreases and the flank wear decreases [7]. Furthermore, by supplying high-pressure coolant, the chip breakage performance is also improved [4-6]. Therefore, studies on high-pressure coolant cutting of difficult-to-cut materials such as titanium alloy [8-12] and Inconel [7, 13] has been carried out in addition to the above. However, in the grooving turning of nickel-based alloys with a high-pressure coolant supply the effects of the coolant pressure on the cutting performance have not been reported.

In this study, in grooving turning of Inconel 718 with a pressure coolant supply, the chip configurations and the tool wear were experimentally investigated.

CONCLUSION

In this study, Inconel 718 was grooving turned with a pressurized coolant supplied, and the chip configurations and the tool wear were experimentally investigated.

The following results were obtained:

(1) The pressure coolant supply method improved the chip breakage performance.
(2) In the case of low-pressure coolant supply cutting, the mass per chip increased with increasing cutting speed. However, in the case of high-pressure coolant supply cutting, there was no difference in the mass per chip even if the cutting speed was increased.
(3) It seemed that the bending of chips caused by high-pressure fluid has a large influence on chip breakage in high-pressure coolant cutting.
(4) Comparing the cutting of the conventional coolant supply cutting with the cutting of the pressure coolant cutting, the tool wear with the pressure coolant supply was smaller than that with the conventional coolant supply.
(5) Comparing the cutting of the low-pressure coolant supply with the cutting of the high-pressure coolant supply, the tool wear with the high-pressure coolant supply was smaller than that with the low-pressure coolant supply.

ACKNOWLEDGMENT

I am grateful to Mr. Yusuke Morigo, who is a researcher at TOKUPI Corporation (3-167 Otake Yao Osaka, 572-8530, JAPAN) and Mr. Ryo Sakurai, who is a student of the National Institute of Technology (Nara College), for their help in the execution of the turning experiment. I would like to thank TOKUPI Corporation for their support in the thread turning test, which enabled this work to be conducted. I would also like to express my gratitude to Tungaloy Corporation for supplying the grooving insert and the external grooving turning holder.

REFERENCES

[1] N. H. A. Halim, C. H. C. Haron, J. A. Ghani, M. F. Azhar, “Tool wear and chip morphology in high-speed milling of hardened Inconel 718 under dry and cryogenic CO2 conditions,” Wear, vol. 426–427, Part B, pp. 1683-1690, April 2019
[2] E.O.Ezugwu, "Key improvements in the machining of difficult-to-cut aerospace super alloys," International Journal of Machine Tools and Manufacture, vol. 45, Issues 12-13, pp. 1353-1367, October 2005
[3] E. O. Ezugwu, J. Bonney, “Effect of high-pressure coolant supply when machining nickel-base, Inconel 718,” alloy with coated carbide tools, Journal of Materials Process Technology, 152-154, pp. 1045-1050, 2004
[4] Tadahiro Wada, Kazuki Okayama and Yusuke Morigo, “Tool Wear of Sintered Cubic Boron Nitride Compact in Cutting Hardened Steel with High-Pressure Coolant Supplied,” High Performance and Optimum Design of Structures and Materials II, Vol. 166, pp. 191-200, 2017
[5] E. O. Ezugwu, “High speed machining of aero-engine alloys,” Journal of the Brazilian Society of Mechanical Sciences and Engineering, 26(1), pp. 1-11, 2004.
[6] Tadahiro Wada and Kazuki Okayama, "Tool wear of poly crystalline diamond in cutting Ti-6Al-4V alloy with high-pressure coolant supplied", Proceedings of 2017 8th International Conference on Mechanical and Aerospace Engineering (ICMAE), July 2017, Prague, Czech Republic, pp. 50-55 (DOI: 10.1109/ICMAE.2017.8038616)
[7] K. ITAKURA, M. KURODA, Y. DOI, H. TSUKAMOTO, Y. ARIURA, “High Speed Cutting of Super Heat Resisting Alloy Inconel 718 -On the Finish Cutting with High Pressurized Cutting Fluid-,” vol. 66, pp. 1611-1615, 2000 (in Japanese)
[8] Y. Ayed, G. Germain, A. Ammar, B. Furet, “Tool wear analysis and improvement of cutting conditions using the high-pressure water-jet assistance when machining the Ti17 titanium alloy,” Precision Engineering, vol. 42, pp. 294-301, 2015
[9] Z.G. Wang, Y.S. Wong, M. Rahman, “High-speed milling of titanium alloys using binderless CBN tools,” International Journal of Machine Tools and Manufacture, vol. 45, Issue 1, pp. 105-114, January 2005
[10] Z.G. Wang, M. Rahman, Y.S. Wong, “Tool wear characteristics of binderless CBN tools used in high-speed milling of titanium alloys,” Wear, Vol. 258, Issues 5–6, pp. 752-758, February 2005
[11] E. O. Ezugwu, R. B. Da Silva, J. Bonney, Á. R. Machado, “Evaluation of the performance of CBN tools when turning Ti-6Al-4V alloy with high pressure coolant supplies,” International Journal of Machine Tools and Manufacture, 45-9, pp. 1009-1014, 2005
[12] Rosemar B. da Silva, Álisson R. Machado, Emmanuel O. Ezugwu, John Bonney, Wisley F. Sales, “Tool life and wear mechanisms in high speed machining of Ti-6Al-4V alloy with PCD tools under various coolant pressures,” Journal of Materials Processing Technology, vol. 213, Issue 8, pp. 1459-1464, 2013
[13] Tadahiro WADA, Yusuke MORIGO, Hiroaki TANAKA, "Tool Wear of Sintered Cubic Boron Nitride Compact in Cutting High-Nickel Alloy with High-Pressure Coolant Supplied", Journal of the Japan Society of Powder and Powder Metallurgy, vol. 63, Issue 4, pp. 157-165, 2015 (in Japanese)