Investigations on Effect of Cutting Parameters on Cutting Tool

B.Akhil[1], Dr.B.Nageswara Rao[2], Dr.R.Babu[3]

[1] Swinburne University, Melbourne Australia.
[2, 3] Professor, Department of Mechanical Engineering,
Mahaveer Institute of Science and Technology, Hyderabad, Telangana, India.
akhi123@gmail.com, bnrao44@gmail.com,mailbabumail@gmail.com

Abstract

During metal cutting operations it is necessary to study the cutting parameter which affects the tool life, the parameters considered in this study are speed, feed, depth of cut, machinability, cutting tool material, spindle speed, tool geometry, coolant and rigidity of the machine. In this work and experimental investigation is carried out to the effect of tool life by changing the cutting parameters like speed feed and depth of cut.

Key words - ***Speed, Feed, Depth of cut, Machinability.***

Introduction

Cutting speed of a tool is defined as the rate at which its cutting edge passes over the surface of the work piece in unit time. The cutting speed is an important aspect in machining since it considerably affects the tool life and efficiency of (surface finish and cost of production) machining [1]. If it is too high, the tool gets overheated and its cutting edge may fail, needing regrinding, if it is too low, too much time is consumed in machining, which results in lowering the productivity and increasing the production cost . In general, the speed of a blade is limited by equipment, quality of the blade, and stone material. Cutting speed has the greatest influence on tool life [2]. As the cutting speed increases the temperature also increases, tool life is rapidly reduced. On the other hand if cutting speeds are low, tool life is long but the rate at which material removed is also low. The heat is more concentrated on the tool than the work and the hardness of the tool matrix changes so the relative increase in the hardness of the work accelerates the abrading action. The criterion of wear is dependent on speed [3].To cut the granite, the speed of blade shall be selected in the range of 25-35m/s. For granite with high and hard cutting the more force required to remove the material and the more rapid the wear on the tool, the speed of blade shall be taken in lower limit. For producing tile of granite, speed can be reached to 35m/s. The size of chip cross-section affects the forces due to cutting and, consequently, the amount of heat generated. Tool wear is more rapid with an increase in cutting speed than with an increase in chip cross-section [4]. For this reason, an increase in production capacity at a given tool life can be provided by increasing the cross-section of the chip removed and not the cutting speed. In such cases, the cross-section of chip should be increased by increasing the depth of cut and not the feed. In general, high cutting speeds and fine feeds give the best surface finish. An increase in cutting speed will result in more intensive heat generation, consequently, more heat resistant tool materials should be used when machining at high cutting speeds. These heat resistant tools may be used under heavier feeds than other tool materials [5 & 6].

Feed of the cutting tool is defined as the distance it travels along or into the work piece for each pass of its pointer to a particular position in unit time and the feed is basically considered per tooth of the cutter. Feed is the amount of material removed for each revolution or per pass of the tool over the work piece. Generally, increasing the feed rate reduces tool life. Removing more material creates more heat. Heat degrades the work piece and the tooling. If feed is reduced, the tool life will improve. The feed depends on factors such as size, shape, strength and method of holding the component, the tool shape and its setting as regards overhang, the rigidity of the machine, the depth of cut, power available etc [7 & 8]. Generally, soft stone, like marble when cut, will increase the feed. Rough grain structure and uneven soft and hard granite, when cut reduces feed. The feed of cutting granite is normally selected between the range 0.5to 1m/min. The maximum feed possible however it must not be greater than that which will produce an acceptable surface finish.

This can be limited by the amount of material that is to be machined, power available rigidity of the work piece and setting depth of cut has the least effect on the tool life. The depth of cut is the thickness of the material removed in one pass of the work under the cutter it is perpendicular distance measured between the original and final surface of the work piece. Cutting depth is related to diamond abrasion, effective cutting, blade stress condition, stone nature (9 &10).

2. Experimental Details

2.1. Experimental Setup

By using precision lathe (Make-Hindusthan Machine Tools Limited) the experimental investigation is carried out on a high speed precision lathe under wet condition with soluble oil. Stainless steel is used as a work piece used for turning operation (11). The working samples used in this investigation are round bars of 34 mm diameter and 650 mm length. Carbide tool is used as a cutting tool (Sandvik Coromant make).

2.2 Process Parameters

Based on the literature survey the working ranges of the parameters have been chosen for machining operation. In the present experimental study the parameters chosen are viscosity of coolant, length of work piece, machining time, depth of cut and feed rate. Table 1 shows the input and output parameters of this study.

Table 1: Process Parameters

Sl. No.	Viscosity of coolant	Length of piece (m)	Machining time (min)	Depth of cut (m)	Feed rate (m/min)	Tool wear (mm)	Tool life Experimental (min)	Tool life predicted (min)
1	Water	1.06	12.85	0.30	0.0824	0.029	8862	8862
2	Water + Oil (1.35)	1.08	12.10	0.30	0.0892	0.023	11051	10521
3	Water + Nirma (1.80)	1.10	10.15	0.30	0.1084	0.017	12125	11941
4	Water + ETA (1.40)	1.08	11.95	0.30	0.0903	0.021	11380	11321
5	Water + surf excel (1.85)	1.10	10.05	0.30	0.1094	0.016	12563	12348
6	Kerosene (2.20)	1.10	9.25	0.30	0.1189	0.014	13214	13511
7	Diesel	1.06	9.15	0.30	0.1158	0.012	15250	16395

3. Results and discussion

Three different work piece of dimension such as 1.06m,1.08m and 1.1 m is used in this experimental study for the study of tool wear and tool life. During machining various coolants are used (water, water with oil, water with nirma, water with ETA, kerosene and diesel).The cutting operation is carried out for various combination of work piece and cutting fluids. Table 1 gives the results about the machining time, feed rate and tool wear. The lowest value of tool wear is achieved when diesel is used as coolant, also the machining time and feed rate is reduced drastically. The experimental tool life is increased when the viscosity of the cutting fluid increases. In addition the experimental and theoretical tool life value matches very closely.

Conclusion

In high speed cutting of granite material, the increased speed significantly increases the temperature at the cutting zone. Consequently this leads to drastic reduction of the tool life simultaneously with feed rate. By using high viscous fluids the tool life is enhanced with low temperature.

References

1. Gokhan Aydin, Izzet Karakurt and Kerim Aydinder department of mining engineering, karadeniz technical university, 61080 Trabzon, Turkey.

2.A.G. Mamalis, R. Schulze, H.K. Tonsoff, "The slotting of blocks of hard rock with a diamond segmented circular saw blade", Industrial Diamond Review, Vol.39, pp. 356-365, 1979.

3. Xin Wei, Chengyong and Hui Yuan Faculty of mechanical & electronic engineering, Guangdong University of Technology, Guangzhou J10090 P.R.CHMA.

4. Z.Nitkiewicz et.al faculty of processing & materials engineering, 'wear effect in granite cutting'.

5. De Hong Zhao et.al, 'Wear cutting in granite machining', 2013, advanced materials research, 774-776, 1026.

6. Cong Fu Fang, Xi Peng Xu, 'Effect of cutting fluids on granite machining', material science forum 626-62 , 213

7. Aslantas K, Ozbek O, Ucun I, Buyuksagis İ S. Investigation of the effect of axial cutting force on circular diamond saw blade used in marble cutting process [J]. Materials and Manufacturing Processes, 2009, 24(2): 1423–1430.

8. Grindwell Norton Ltd, Cutting Fluid, obtained from ww.grandwellnnorton.co.in/home.htm.

9. Wang J, AI X, XU G, Zhang J. Experimental study for the cutting forces during sawing granite with diamond circular saw blades [J]. Key Engineering Materials, 2010, 431/432: 86–89.

10. A. Di Ilio and A. Togna, "A theoretical wear model for diamond tools in stone cutting," International Journal of Machine Tools and Manufacture, vol. 43, no. 11, pp. 1171–1177, 2003.

11. X. Wei, C.Y. Wang, Z-H. Zhou, "Study on the fuzzy ranking of granite saw ability", Journal of Materials Processing Technology, Vol.139, pp.277-280, 2003.