EXPERIMENTAL INVESTIGATION OF EFFECT OF CUTTING PARAMETERS ON HSS TOOL LIFE IN TURNING OPERATION

Nitin Jain[1], Prof. Swati D. Chaugaonkar[2]

[1]Nitin Jain Student, M.E. (Tribology and maintenance),

[2]Assistant Professor, Mechanical Engineering Department,

Shri G.S. Institute of Technology & science Indore (M.P.)

ABSTRACT

The objective of the study is finding to the optimum machining parameters so as to minimize the tool temperature and tool wear for the selecting tool and work materials in the chosen domain of the experiment. Metal cutting process depends on parameters such as cutting speed, feed, depth of cut, tool material and geometry, work piece materials etc. In this work the tool wear and temperature effect at various depth of cut in turning operation are studied. Coolant effect on tool life is studied also. Machine time reduced by increasing the speed, depth of cut and feed is observed during the experimental work which results in increasing the productivity. Tool temperature is measured by the infrared thermometer. The tool wears measure by the weight loss of tool material with the help of electrical digital weight machine. Experiments are performed at different cutting parameters then optimized speed, depth of cut and feed rate to minimize tool wear.

Key words: *Tool temperature, Tool wear, turning, volume weight ratio*

I. INTRODUCTION

Industry is very closely linked to economics and the machining operations and they play a predominant role in manufacturing parts. The rate of production and the cost per piece are two main factors for manufacturing industry. The rate of production increases by decreasing the machining time and machining time decreases by increasing the speed. But if cutting speed is increasing, then tool temperature increases which in turn reduces the tool life and also affect the quality of work. So how to increase tool life and maintain the higher production rate are big problem for manufacturing industry. My experiment work is to determine the tool life, which are directly related to tool temperature and tool wear and the production rate are determined by the ratio of volume of material removed and tool weight loss. Calculations are performed at different depth of cut at constant feed rate 0.055 mm/rev and speed 315 rpm with and without coolant. Chilled water is used as a coolant which is flowing through an isolated thermal container. Temperature is controlled with the help of thermal flask container. Coolants are flowing in the form of drop through small diameter pipe.

Turning is metal cutting process, which remove the material in form of chips from the work piece. The diameter of cylindrical rod is reducing by a single point cutting tool in turning process [1]. All turning operation performs

RISEM - 16
ISBN : 978-93-86171-07-8

are done in lathe. The relative motion between tool and the work responsible for cutting action is known as cutting motion and that responsible for gradually feeding the uncut portion is termed as secondary or feed motion. The Machining Tool is lathe machine in turning operation which provides the relative motion between tool and workpiece [2]. The Cutting tool is single point cutting tool which is provides the mechanical contact between tool and work piece. Operating conditions are affected by every single parameters change of machining which in turn affects the production rate, quality and cost of product. So according to operating condition, the cutting parameters are decided and operations are performed. The tool material selected according to workpiece, environmental conditions and cutting conditions [3]. Following characteristic are required for tool material

- Hot Hardness
- Toughness
- Friction coefficient
- High Thermal conductivity
- Specific heat, etc.

Wear is defined as the progressive loss of material from the surface of a body due to friction [4]. Wear is one of the most common causes of failure of engineering materials. Tribology, the study of wear, friction and lubrication is as old as human culture yet it is considered as the Science of the future. Tool wear is a large problem for metal cutting operations. If the Tool wear increases then tool life decreases and this in turn affect the production rate, quality of product and cost. The main cause of Tool wear is to increase temperature of tool. Many types of tool wears are generated due to wear mechanism [5]

II. EXPERIMENTAL WORK

In this work we have and observed different characteristic at various operating conditions. The temperatures and tool weight are observed by infrared thermometer and electrical weight machine respectively after that calculate the tool wear, Electrical unit consumptions and volume weight ratio. The length of work piece is 68 cm which are constant throughout the experiment and constant feed rate is 0.055 mm/revolution. Take fixed tool geometry or tools angles throughout the experiment

Table 1 Cutting Parameters

Name of operation	Turning
Spindle speed	315 (rpm)
Depth of cut	0.5, 0.6, 0.7, 0.8, 0.9, (mm)
Feed rate	0.055 mm/rev.
Environmental conditions	Dry and wet
Work piece	Mild steel

Table 2 Tool Specification

Tool material	High speed steel
Tool types	Single point cutting tool

ISBN : 978-93-86171-07-8

Tool size	6 inch length and ½ inch tool bit
Tool geometry	16^0-5^0-9^0-9^0-9^0-13^0-0.1 mm

Fig. 1 Experiment Setup

Fig. 2 HSS Single Point Cutting Tool

Fig. 3 Infrared Thermometer

Fig. 4 Weighing Machine (Citizon Model CY-220)

III. EXPERIMENT PROCEDURE

1. Mild steel rod is used to make work piece. With the help of cutting machine, cut that rod with 68 cm of length
2. Facing of mild steel rod by single point cutting tool on lathe machine and after that centering by the drill tool. The mild steel rod is fixed with help of head stock and tail stock of lathe machine; and then set the feed, depth of cut and speed. The rough surfaces are removed on work piece. The diameter of work piece is measured by the vernier scale. The initial diameter of work piece is 35.5 mm.
3. Select the tool material of high speed steel because of high wear resistance and toughness.
4. Single point cutting tool of constant tool geometry is made with help of grinding machine and then measure the tool weight with the help of Weighing Machine. Initial weight of tool is 70.2671 gram.
5. The work piece is mounted on lathe machine and tool is mounted on tool post.
6. The set cutting parameters and start the turning process.
7. During the machining take temperature of tool and interference temperature with the help of infrared thermometer and complete the machining again measure tool weight with the help of Weighing Machine.
8. Calculate the tool wear and volume weight ratio with the help of observed parameters.
9. Perform step 6 to 8 at different depth of cut at speed 315 rpm and 0.055 mm/rev feed, without using coolant.
10. Now use chilled water as coolant. Coolant is stored in isolated container and coolant temperature is maintained 14 ^{0}c. Coolant is flowing with the help of small diameter pipes and flow is controlled by

ISBN : 978-93-86171-07-8

container valve. The coolant flowed through pipes and is falling at contact point in continuously drops forms. Again repeat steps 6 to 8 using coolant.

IV. RESULTS AND DISCUSSION

4.1 Tool and Interference Temperature

Temperature measured by the infrared thermometer in ^{0}c. I have measured the temperature of tool and interference temperature (cutting point or tool-work piece contact point) at various depth of cut with or without coolant.

Table 3 Depth of cut v/s Temperature at 315 rpm

Speed (rpm)	Depth of cut (mm)	Maximum tool temperature (^{0}C)		Maximum Interferences (^{0}C)	
		without coolant	with coolant	without coolant	with coolant
315	0.5	50.8	36	51.8	38
315	0.75	52	38	59	40
315	1.0	55	42	61	43.5
315	1.25	58	43	65	45.5
315	1.50	60	46	70	47

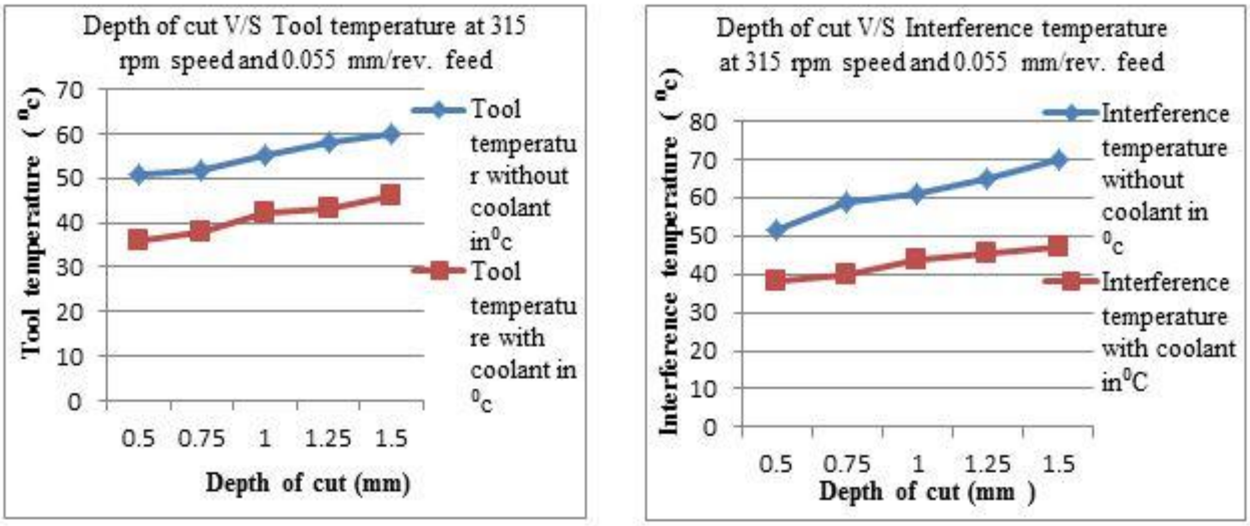

Fig. 5 Depth of cut V/S Temperature at 315 rpm speed and 0.055 mm/rev. feed

4.2 Tool Wear

Tool wears measure by the weigh machine which has high precision instrument. The measurements of the tool weight loss are various speed and depth of cut at with or without coolant. The tool wear is calculated by the tool weight loss during operation.

ISBN : 978-93-86171-07-8

Table 4 Depth of cut V/S Tool Wear

Depth of cut	Speed (rpm)	Tool wear (mgram)		Decreasing tool wear (%)
		Without coolant	With coolant	
0.5	315	1.9	1.1	42.11
0.75	315	1.1	0.4	63.64
1.0	**315**	**0.9**	**0.2**	**77.78**
1.25	315	0.3	0.175	41.67
1.5	315	0.3	0.18	40

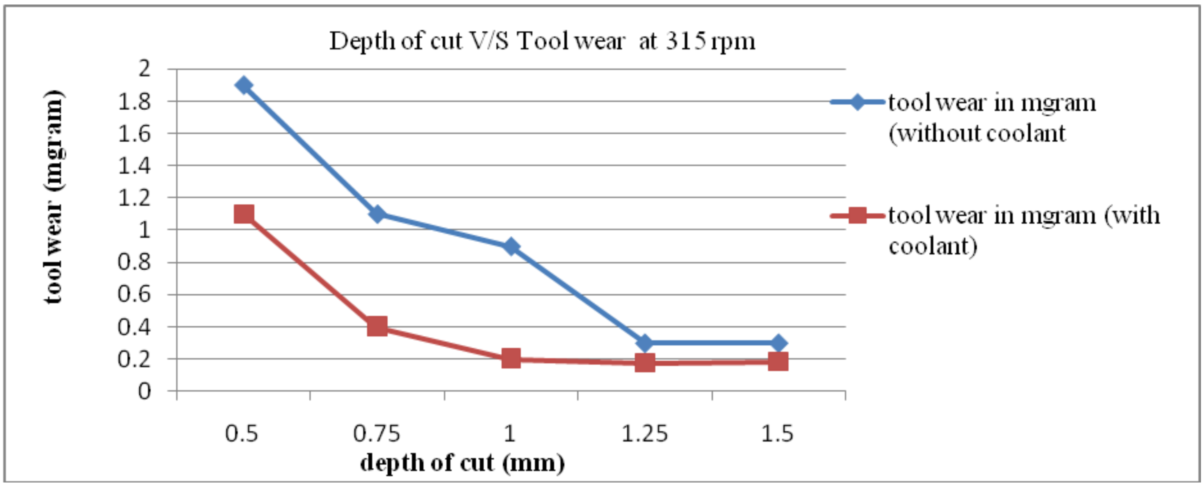

Fig. 6 Depth of cut V/S Tool wear at 315 rpm

4.3 Volume weight ratio

Table 5 Depth of cut V/S Volume Weight Ratio

Depth of cut (mm)	Speed (rpm)	Volume weight Ratio(mm³/mgram)		Increasing volume weight ratio (%)
		Without coolant	With coolant	
0.5	315	19,676.29083	34,471.83939	75.19
0.75	315	46,245.67185	129,178.3629	179.33
1.0	**315**	**71,209.43348**	**325,783.1582**	**357.45**
1.25	315	247,007.7224	431,071.3919	74.52
1.50	315	267,035.3756	453,960.1384	69.99

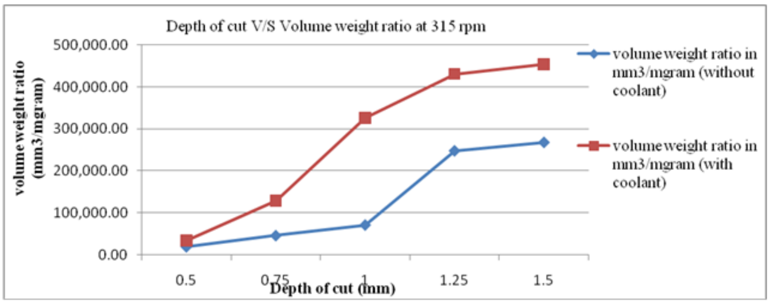

Fig. 7 Depth of cut V/S Volume weight ratio at 315 rpm

V. CONCLUSION

In this work, experiment is performed to check the effect of cutting parameter on HSS tool life during turning operation. Tools were checked with or without coolant after every experiment .Following are the conclusions made from this work (1) Tool surface temperature and tool-workpiece interference temperature are increase with increasing the depth of cut. Interference temperature is more increasing compare to tool surface temperature. Tool surface temperature is decreasing 10-15^{0}c and Tool- workpiece interference temperature is decreasing 12-23^{0}c by coolant used so Increasing the tool life by coolant because decreasing tool temperatures. (2) Tool weight loss is decreasing with increasing the depth of cut. Tool weight loss is decreasing when coolant used and increasing the tool life. The maximum percentage of tool weight loss reductions is 77.78 % at speed 315 rpm, 1.0 mm depth of cut and 0.055 mm/revolution feed. (3) Volume weight ratio is directly related to productivity. If volume weight ratio is more than maximum productivity. The volume removes from the workpiece are increasing when increasing the depth of cut which directly related to MRR. Volume weight ratio is directly promotional to depth of cut. The volume weight ratios are increasing more by coolant used and productivity also increasing. The maximum percentage of volume weight ratio increasing is 357.45 % at speed 315 rpm, 1.0 mm depth of cut and 0.055 mm/revolution feed.

REFRENCE

[1] H. Sodhi, B. Singh, Dr. D. Khanduja,Behavior Study of Cutting Parameters on Material Removal Rate for a Non-Ferrous Material while Turning on a CNC Turning Center, International Journal of Applied Engineering Research, Vol: 7 Issue: 11, 2012, pp 1-3

[2] book: manufacturing science (amitabhaGhosh $ Asok Kumar Malik)

[3] L. Kumari, S. I. Sadaq., G. P. Kumar, Analysis of Single Point Cutting of a Lathe Machine using FEA, International Journal of Engineering Trends and Technology, Vol: 20 Issue: 5, 2015, pp 214-217

[4] Y. Yildiz, M. Nalbant, A review of Cryogenic Cooling in Machining Processes, International Journal of Machine Tools & Manufacture, Vol: 2 , 2008, pp 947-964

[5] M. Patil, Dr. R.J. Patil, Study Effect of HSS Single Point Cutting Tool Nose Radius on Cutting Edge Strength and Tool Wear in Machining of EN9, International Journal of Science and Research, Vol: 3 Issue: 12, 2014, pp 2563-2567