Influence of Cutting Fluid Conditions and Cutting parameters on Material Removal Rate (MRR) in Taper Turning Process of EN31

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Abstract— The present scenario depicts many surveys that represent the machining industries using cutting fluid have more trouble in employee health as well as environmental pollution. The introduction of minimum quantity lubrication has brought disadvantages of wet machining process to been replaced by Minimum Quantity Lubrication (MQL). MQL is increasingly finding its way into the area of metal industries. It has already established as an alternative to conventional dry and wet machining methods. In contrast to Dry and Flood lubrication, Minimum Quantity Lubrication use only a few drops of the fluid approx. 5 ml to 100 ml per hour for the machining. The aim of the research is to determine the Minimal Quantity Lubrication (MQL) technique when used for Taper Turning process in CNC Lathe can produce remarkable advantages in Types of Chips formed during the process and the Microstructure. The work piece material that is used in the experiments is EN-31 steel while the carbide is a cutting tool material. Fluid selection is the most important part of MQL machining process; hence the quality of the fluid depends on it. Therefore a superior type such as vegetable oil or synthetic oil is used for lubrication as well as for cutting fluid for machining. The costs of these fluids are high but it eliminates the commitment of costly fluid's recycling and disposal service. On our analysis, it was found that MQL produces better surface finish than the wet machining process and has surprisingly shown its significance which reduces the cost of the machining process and is also eco-friendly. Hence leading to safe and uninterrupted machining process.

Key words: Material Removal Rate (MRR), EN31, Minimum Quantity Lubrication (MQL)

I. INTRODUCTION

Manufacturing can be defined as the transformation of materials into goods for the satisfaction of human needs. It can be analysed as a system in which product designing is the initial stage while the product delivering is the final stage. It alters the form, shape or physical properties of the workpiece material provided. Metal removing process or machining process is most widely used and accepted process in the mechanical manufacturing industry. It mostly includes several operations such as turning, taper turning, milling, drilling, boring, reaming, grinding etc. Out of these machining operations, turning and taper turning is still the most important operation for the machining process. In taper turning operation, a higher value of cutting parameters offers opportunities for increasing the productivity and fined taper diameter of the workpiece.

However, the use of wet machining is questionable in the recent times as it is concerned with environmental hazards, the health of the worker, and expenditure for lubricant rectification, maintenance and disposal. In spite of many attempts to discourage the use of cutting fluids completely, it is still essential to obtain an economical tool life and required surface integrities. It is applicable in narrow tolerances, high dimensional accuracies are required or if hard metals are to be machined. It is estimated that the cost of cutting fluids is in the range of 7%-17% of the total costs in the industry.

The increased rate of wet machining hampers the working capital of the industry. Thus there arises a need for alternatives which can serve the purpose of cutting fluids applied in flooded conditions. One such alternative is the use of minimum quantity lubrication also known as MQL. The concept of minimum quantity lubrication (MQL) is delivering a very small amount of coolant to the chip-tool interface in the form of an oil mist or aerosol, as opposed to traditional techniques of flooding the workpiece and tool with a substantial volume of liquid coolant. Minimum Quantity lubrication is also known as semi-dry lubrication or micro lubrication. The concept of MQL suggests usage of a very insignificant amount of cutting fluid in the range of 50-300 ml per hour as compared to flood cooling which consumes 5 to 50 litres of cutting fluid per hour. Minimum quantity lubrication represents an interesting alternative which combines the functionality of cooling lubrication with an extremely low consumption of cutting fluids. MQL has been suggested since a decade ago as a mean of addressing the issues of environmental and occupational hazards associated with the airborne cutting fluid particles on factory shop floors leading to degradation in the health of the worker. The minimization of cutting fluid also leads to economic benefits by way of saving lubricant costs and workpiece/tool/machine cleaning cycle time.

II. TAPER TURNING

A taper is a uniform change in the diameter of a workpiece when measured along its axis (Figure 1). While tapers created on a lathe are cylindrical, a taper created on a mill can be flat-sided or angular, like a wedge.

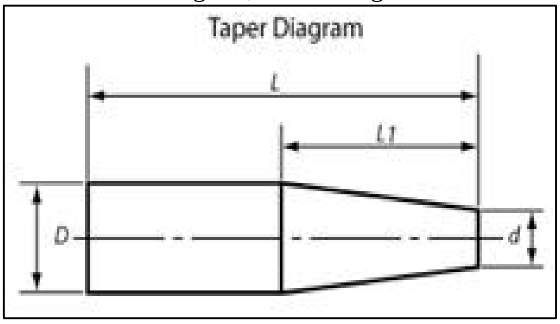

Fig. 1: A taper is a uniform change in a cylinder's diameter when measured along its axis. The section labelled L 1 shows a taper.

The method used for turning a taper depends on the degree, length, location of the taper (internal or external), and the number of pieces to be done. The three basic methods of turning a taper require the operator to use either a compound rest, offset the tailstock, or use the taper attachment. With any of these methods, the cutting tool must be set exactly on centre with the axis of the workpiece to be truly conical, and the rate of taper will vary with each cut. Turning a taper on a lathe can be complicated, depending on the method chosen to perform the operation. Simply put, a taper is created by angling the workpiece and cutting tool relative to one another as the tool travels along the workpiece. As the tool travels along the workpiece, it gradually cuts deeper or shallower, creating a tapered surface, such as the tapered section in Figure 3.

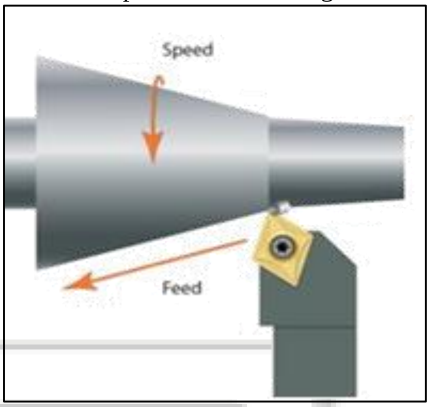

Fig. 3: A taper is turned on a lathe by cutting at an angle relative to the workpiece centerline.

III. Lubricant

A Lubricant is a substance (often a liquid) introduced between two moving surfaces to reduce the friction between them, improving efficiency and reducing wear. Lubricants perform the following key functions

- Keep moving parts apart.
- Reduce friction.
- Transfer heat.
- Carry away contaminants and debris.
- Transmit power.
- Protect against wear.
- Prevent against wear.
- Seal for gases.

Stop the risk of smoke and fire of objects. Panama oil (Soluble oil) is used as a coolant during the machining. The Soluble based oil could produce better result than the mineral reference oil in view of increased machining performance as well as renewable source.

IV. Material Removal Rate (MRR)

Up till now we have worked on MRR i.e Material Removal Rate and also recorded the readings. On theoretical calculation, we have obtained some values for optimum solution as given in the table.

The material removal rate in turning operation is the volume of the material removed per unit time in mm^3 /sec.

Material removal rate=(1000x v x f x d)/60

Where, v = cutting speed

f = feed rate

d = depth of cut

Factor Code	Unit	Level 1	Level 2	Level 3
Cutting Speed A	m/min	130	160	190
Feed B	mm/rev	0.2	0.3	0.4
Depth of Cut C	mm	0.1	0.1	0.1

Table 1: Process Parameter and their Level

No.	Cutting Speed	Feed	Depth of Cut	MRR	SNRA1
1	1	1	1	43.33	32.7358
2	1	2	2	65.00	36.2583
3	1	3	3	86.66	38.7564
4	2	1	2	80.00	38.0618
5	2	2	3	106.6	40.5600
6	2	3	1	53.33	34.5394
7	3	1	3	126.6	42.0528
8	3	2	1	63.33	36.0322
9	3	3	2	95.00	39.5545

Table 2: MRR Calculation

V. Conclusion

In the Taguchi method there are three Signal-to-Noise ratios for optimum results.

1) Smaller the better
2) Larger the better
3) Normal the best

For the material removal rate (MRR) Larger is the better is optimum solution. Hence From Table no. 2, 7th iteration is our optimum solution.

References

[1] Experimental Investigation on Turning of EN-24 by Taguchi Method in Different Cutting Environments Prof. Praful P. Ulhe, L. Kewalsaiprasad Department of Mechanical Engineering, J D College of Engineering and Management, Katol Road, Nagpur.

[2] Vegetable Oil As An Alternate Cutting Fluid While Performing Turning Operations On A Lathe Machine Using Single Point Cutting Tool Mohd SaadSaleem, Mohd. Zafaruddin Khan, Md ZakaullahZaka Department of Mechanical Engineering, University Polytechnic, Integral University, Lucknow (U.P.), India.

[3] Machining Using Minimum Quantity Lubrication: A Technology for Sustainability Nourredine Boubekri, Ph.D. Professor Department of Engineering Technology University of North Texas Discovery Park 3940 N. Elm St, Suite F115B, Denton, TX, 76207 United States of America.

[4] Surface roughness and cutting force prediction in MQL and wet turning process of AISI 1045 using design of

experiments† Young Kug Hwang and Choon Man Lee* Department of Mechanical Design & Manufacturing Engineering, Changwon National University, #9 Sarim-dong, Changwon-si, Gyeongsangnam-do, 641-773, Korea.

[5] Minimal quantity lubrication in turning: Effect on tool wear A. Attanasio∗, M. Gelfi, C. Giardini, C. Remino, Department of Mechanical Engineering, University of Brescia, Via Branze 38, 25123 Brescia, Italy.

