

Comparison of Tools in Turning Process

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Abstract— In the turning operation, properties of tools, work-pieces and different input parameters affect the output characteristics and efficiency of the machine. Improvement in process and efficiency can be obtained by optimization of different input parameters which lead to required or desired output with acceptable variations in values which takes the manufacturing process at low cost. To determine the effectiveness of cutting tool, we need to estimate the tool life with reasonable surface finish. We have selected two different tools such as Cemented Carbide and Tungsten Carbide for machining of Aluminium (AL T6061) as workpiece material. Since no machining theory is available for prediction of tool life here we select an appropriate orthogonal array method for the experimentation. By this experiment, we get the numerous comparisons between machining parameters of different cutting tools and then we get the optimum tool life compared to other. For a practical machining situation, since there is no adequate machining theory available to predict the tool life, one is bounded to rely on empirical equations which involve a number of constants that are not readily available. Therefore, this paper proposes an alternative method to determine the optimal process parameters used to forecast cutting forces, tool life and surface finish.

Keywords— Tungsten Carbide, Cemented Carbide, Orthogonal array, empirical equation and Tool.

I. INTRODUCTION

Machining operations is essential for manufacturing industry. The available optimization researches for CNC (Computer Numerical Controlled) turning were simulated within particular manufacturing conditions or achieved through frequent equipment operations. The machining process on a CNC lathe is programmed by Speed, Feed rate, and depth of cut, which are frequently determined based on the job shop experience. However, the machine performance and the product characteristics are not definite to be acceptable. Therefore, the finest turning conditions needs to be acquired. It is mentioned that the tool nose run-off will affect the performance. In the modern industry, the goal is to manufacture low cost, high-quality products in a short time. Automated and flexible manufacturing systems employed for that purpose along with Computer Numerical Control [CNC] that are capable of achieving high accuracy at very low processing time. The change of the machining parameter has been examined related to the change of Speed, feed rate and depth of cut and the quality of surface finish. A significant upgrading in process efficiency may be obtained by process parameter optimization that identifies and determines the regions of critical process control factors leading to desired outputs or responses with acceptable variations ensuring a lower cost of manufacturing. For a machining process such as turning, the cutting conditions like cutting speed, feed, depth of cut and cutting fluids play an important role in the efficient use of a machine tool.

II. TOOL LIFE

Tool life generally indicates the amount of acceptable performance or service rendered by a fresh tool or a cutting point till it is declared abortive. The tool life with respect to R & D and Industry viewpoint can be defined as follows

- **In R & D:** Real machining time (period) by which a fresh cutting tool (or point) satisfactorily works after which it needs replacement or reconditioning. The modern tools hardly fail early or abruptly by mechanical breaking or rapid plastic deformation. They fail mostly by wearing a process that steadily grows slowly with machining time. In that case, tool life means the span of real machining time by which a fresh tool can work before attaining the specified limit of replacement of tool due to wear.
- **In industries:** The length of time of satisfactory service or amount acceptable output provided by a fresh tool prior to it is required to replace or recondition.

In R & D, tool life is always measured or expressed by a span of machining time (T) in minutes, whereas in industries tool life is measured depending upon the situation, such as the number of workpieces machined, the total volume of material removed and total length of cut during machining. Taylor's has proposed a tool life equation by considering different machining parameters like Cutting Speed (s), Feed Rate (f) and Depth of cut (d).

$$T^n = \frac{C}{V F_x D_y}$$

Where,

T = Tool life in min.

F = Feed in mm per revolution

d = Depth of cut in mm.

V = Velocity in mm. per minute

n = Tool constant

n₁ = Feed exponent constant

n₂ = Depth of cut exponent constant

C = Constant

The value of constant (C) in the formula will be taken from the manufacturing data book and (n, n₁, n₂) from tool manufacturing databook. All these constant values depend on the material of the tool and workpiece. After experimenting for the tool life and surface roughness, we will take the best parameter which is suitable for the particular tool.

III. RELATED WORK

Literature on machining is a huge and considerable amount of work that has been done on the analysis of tool life during machining. Most of the existing research focuses on influence of different parameters on tool life. Some literature related to the proposed works is given below.

Alper Yontar, et.al.[1] The test was performed without coolant at a various feed rate, cutting speed and depth of cut. Tool life, surface roughness, and cutting force have been determined experimentally. The relationship between cutting parameters and tool life was modelled with surface response method and analyzed using statistical process analysis. Samir Khamei, et.al.[2] The cutting force and surface roughness are measured at the end of useful for tool life. The combined effect of process parameters on performance is done by using ANOVA (Analysis of variance). C.J.Rao, et.al.[3] The result showed that the tool life is decreasing as the cutting force, MRR and cutting speed increases. The MATLAB result showed that the best surface finish is approximately equal to the average of three stage output. G.Harinath gowd, et.al.[4] Experiments are done as per depth of cut and feed is taken as the process parameter and output parameters are fixed fx and temperature. By using MATLAB software, ANN model is available which is used to predict the relationship of input process parameters and output variable. S.J.Ojolo, et.al [5] The effect of Feed rate at (0.3mm/rev) was evident on the tool life-giving shorter tool life in all cases using experimental data, a multiple linear regression model was developed and proves to be effective in optimizing the cutting condition in Turning operations. Devendra singh, et.al [6] The effect of nose radius on surface roughness in CNC turning of Aluminium (6061) in dry condition. The effect of cutting conditions (speed, feed, depth of cut) and tool geometry (Nose radius) on surface roughness were studied and analyzed by using RSM (Response surface methodology). Karol Vasilko, et.al [7] This paper provides results for supporting the decisions of the technologists and manufacturers in finding the way to improve the technological process, its productivity keeping the quality and economy. When combining the tool coating and freezing treatment, the achieved tool life was up to 8 times longer.

IV. CUTTING TOOL AND WORKPIECE MATERIAL

In this experiment, we will take two different tools (TUNGSTEN CARBIDE / CEMENTED CARBIDE) which are commonly used in industry for turning operations in CNC Machine. Aluminium is chosen as the workpiece material because of its soft machining and is light in weight.

V. EXPERIMENT

The experiment was carried out on CNC lathe machine in Metalok Industries, Mira Road (East). This Company designs, develops and Produces high quality products which includes Instrumentation valves, precision pipe & compression tube fittings, thermowell, hose & hose fittings, air manifolds and condensate pots, flanges and other consumables in all grades of material used in Chemicals & Petrochemicals, Food and Beverages, Pharmaceuticals, Marine, Oil and Gas Industries, Power Generation, Pulp and Paper, Semiconductor Industries. Turning process was done on Aluminium (AL T6061) as workpiece and Cemented Carbide and Tungsten Carbide tipped tool as the cutting tools. After machining, we check the Surface Roughness value (Ra) of the workpiece with the help of a surface roughness tester machine.

Input Parameters:

- 1) Speed
- 2) Feed Rate
- 3) Depth of cut

Table 1
Process Parameters for Inputs

Parameter Designation	Process Parameter	Level 1	Level 2	Level 3
A	Speed (RPM)	800	1000	1200
B	Feed Rate (mm/rev)	0.15	0.2	0.25
C	Depth Of Cut (mm)	0.4	0.6	0.8

In this Experiment, the Input Parameters were Speed, Feed Rate, and Depth of Cut and its Output Parameters are Tool Life, and Surface Roughness. In this we took 3 readings for each parameter resulting in total 9 parameters in the input value.

After this using Orthogonal Array method, we took one parameter as constant and varied the other two parameters for performing the experiment in different input values. This make a total of 27 different readings to perform the operation using a single tool. Such a set of 27 readings were experimented using 2 different types of tools, which will make a total of 54 values as the output parameter for the experiment. After the experimentation of all the parameters and its calculation of tool life using Taylor's Tool Life Equation, we selected the best value for getting maximum tool life for every material and then the best value from these experimented values. This is the process which we followed in this experiment.

Table 2
Machine readings and output parameters for Tungsten Carbide tipped tool

Experiment No	Speed (s) (rpm)	Feed (f) (mm/rev)	Depth of Cut (d) (mm)	Surface Roughness (μm)
1	800	0.15	0.4	0.72
2	800	0.15	0.6	1.14
3	800	0.15	0.8	1.31
4	800	0.2	0.4	1.02
5	800	0.2	0.6	0.98
6	800	0.2	0.8	2.12
7	800	0.25	0.4	2.14
8	800	0.25	0.6	2.18
9	800	0.25	0.8	2.3
10	1000	0.15	0.4	1.13
11	1000	0.15	0.6	1.22
12	1000	0.15	0.8	1.41
13	1000	0.2	0.4	1.12
14	1000	0.2	0.6	2.14
15	1000	0.2	0.8	1.24
16	1000	0.25	0.4	1.54
17	1000	0.25	0.6	0.82
18	1000	0.25	0.8	1.16
19	1200	0.15	0.4	0.70
20	1200	0.15	0.6	1.32
21	1200	0.15	0.8	1.41
22	1200	0.2	0.4	1.27
23	1200	0.2	0.6	1.33
24	1200	0.2	0.8	1.61
25	1200	0.25	0.4	1.44
26	1200	0.25	0.6	1.5
27	1200	0.25	0.8	1.32

Table 3
Machine readings and output parameters for Cemented Carbide tipped tool

Experiment No	Speed (s) (rpm)	Feed (f) (mm/rev)	Depth of Cut (d) (mm)	Surface Roughness (μm)
1	800	0.15	0.4	0.82
2	800	0.15	0.6	0.94
3	800	0.15	0.8	0.96
4	800	0.2	0.4	1.12
5	800	0.2	0.6	1.06
6	800	0.2	0.8	1.10
7	800	0.25	0.4	1.44
8	800	0.25	0.6	1.54
9	800	0.25	0.8	1.5
10	1000	0.15	0.4	1.24
11	1000	0.15	0.6	1.2
12	1000	0.15	0.8	1.39
13	1000	0.2	0.4	1.22
14	1000	0.2	0.6	2.43
15	1000	0.2	0.8	1.34
16	1000	0.25	0.4	1.64
17	1000	0.25	0.6	0.82
18	1000	0.25	0.8	1.39
19	1200	0.15	0.4	0.90
20	1200	0.15	0.6	1.32
21	1200	0.15	0.8	2.67
22	1200	0.2	0.4	1.27
23	1200	0.2	0.6	1.29
24	1200	0.2	0.8	1.71
25	1200	0.25	0.4	1.44
26	1200	0.25	0.6	1.5
27	1200	0.25	0.8	1.77

VI. CONCLUSION

In this work, aluminium is taken as a work material and Cemented Carbide and Tungsten Carbide as tool materials. By varying the different parameters like Speed, Feed Rate and depth of cut at different conditions the surface finish parameters were calculated. In the above mentioned tables we find that for experiment no 19 best surface finish was achieved, In case of Tungsten Carbide tipped tool and *Cemented Carbide tipped tool* roughness values were 0.70 μm and 0.90 μm for the same condition respectively. The results showed that the tool tungsten carbide is better in the same condition as that of the Cemented Carbide.

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