STUDY ON EFFECT OF VARIOUS PARAMETERS ON TOOLS FOR TURNING PROCESS.

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Abstract : In our paper we are focusing on how to improve the productivity with optimum tool life and good surface finish. We are using CNC lathe machine for our experiment purpose in our project. There are many operations which can be performed using CNC lathe machine out of which we are using Turning Operation which is most commonly used operation in CNC lathe machine in industries. In the turning operation, properties of tools, work-pieces and different input parameters affect the output characteristics and efficiency of the tool. To determine the usefulness of cutting tool, we need to do the evaluation of the tool life with reasonable surface finish. We are doing the experiment on two different tools such as Tungsten Carbide and Cemented Carbide for machining of Aluminium (AL T6061) as the workpiece material. After this we need to consider the machining parameters to perform the turning operation. The input parameters which are taken into consideration are Speed, Feed, and Depth of cut on CNC machine. In our paper we are mainly taking into considering Tool life as well as good surface finish as the output parameter. We have selected an suitable orthogonal array method for the experimentation. Experiments have been carried out using full factorial method. Therefore, this paper proposes the comparison of the tools used in experiments to get the optimal process parameters of the tools for better tool life and good surface finish.

Index Terms* – CNC, *Tungsten Carbide, Cemented Carbide, Orthogonal array, full factorial method.

I. INTRODUCTION

In modern industry the goal is to manufacture the low cost, high quality products in short time. Automated and flexible manufacturing system were employed for that purpose along with Computerized Numerical Control [CNC] that are capable of achieving high accuracy at very low processing time. The change of machining parameter has been examined related to the change of feed rate, cutting depth and the quality of the metal removed material parameters. In Manufacturing process we have selected CNC Lathe machine named Fanuc with Ace jobber turning centre. Metal cutting plays a pivotal role in innumerable manufacturing processes and is widely used in various engineering industries. Surface roughness is an important parameter of metal cutting as it is the characteristic of quality and influences performance of the mechanical parts and also the production cost. Cost and quality are inversely proportional to each other. Thus we need to find a way to balance both objectives. Thus, selection of proper tool and work- piece combination along with proper input parameters which influences cost and quality can help us to achieve the best possible solution to our problem.

II. TOOL LIFE AND SURFACE FINISH

Tool life generally indicates the amount of satisfactory performance or service rendered by a fresh tool or a cutting point till it is declared as failed. The flank wear will be measured for different inserts in connection to cutting time and for different combinations of cutting parameters. The tool wear zone occurs mostly in the tool nose radius corner on the flank side. In the present work, all the experimental conditions investigated, the flank wear increases with cutting time. In research and development the real time for machining (period) by which a new cutting tool point satisfactorily works after which it needs replacement or servicing. The modern tools very strong and barely fail prematurely by mechanical breaking or rapid plastic deformation. They fail slowly due to the constant wearing of the tools due to the process of machining. 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 tool life is considered as the time of acceptable service output provided by a new tool after which it is required to replace.

Theoretically, tool life is always measured or expressed by a span of machining time (T) in minutes, whereas in industries tool life is considered 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 Extended Tool Life Equation

$$\boldsymbol{V} \times \boldsymbol{T}^{\boldsymbol{n}} \times \boldsymbol{F}^{\boldsymbol{a}} \times \boldsymbol{D}^{\boldsymbol{b}} = \boldsymbol{C}$$

where,

V = Velocity in mm per minute

T = Tool life in min.

F = Feed in mm per revolution

D = Depth of cut in mm

n = Tool constant

a = Feed exponent constant

b = Depth of cut exponent constant

C = Constant

The value of constant (C) in the formula will be taken from Manufacturing Data Book in which different values are given for machining of various materials. The value of (n, a, b) are taken from tool manufacturing company's guide

Constant Values For Tool No 01 (Tungsten Carbide):-
The required Constant values for Taylor's Extended Tool Life Equation Tungsten Carbide Tool is taken from the Tool manufacturer's guidebook. In which different values are given for machining of various materials. Here we have taken the values of Tool exponent constant (n), Feed exponent constant (a), Depth of cut exponent constant (b). Which are 0.33, 0.06 and 0.15 respectively.

Constant Values For Tool No 02 (Cemented Carbide):-
The required Constant values for Taylor's Extended Tool Life Equation Cemented Carbide Tool is taken from the Tool manufacturer's guidebook. In which different values are given for machining of various materials. Here we have taken the values of Tool exponent constant (n), Feed exponent constant (a), Depth of cut exponent constant (b). Which are 0.2, 0.35 and 0.08 respectively.

III. Related Work

Literature on machining is a huge and considerable amount of work that has been done on the analysis of tool life and surface finish during machining. Most of the existing research focuses on influence of different parameters on tool life and surface finish. Some literature related to the proposed works is given below.
C.J.Rao, et.al.[1] 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. Ghani, J.A., Choudhury, I.A. and Masjuki, H et.al [2] This paper presents the performance of uncoated carbide cutting tool when machining cast iron in dry cutting conditions. Experiments were conducted at various cutting speeds, feed rates, and depths of cut according to Taguchi method design of experiment using a standard orthogonal array L9(34). Ezugwu, E.O. and Okeke, C.I. et.al. [3] A P20-30 PVD TiN coated cemented carbide inserts with sharp edges were used to perform an external right hand thread cutting operation on two grades of steel up to a cutting speed and feed rate of 225 m min−1 and 0.44 mm rev−1, respectively. The test results show that cutting speed and feed rate had the most significant influence on tool life. Yahya Isik, et.al.[4] The objective of the present work is to assess the effect of different coating materials on machinability in the turning of AISI 1050 steel. The machining performance of different coating materials was evaluated. In addition, cost analysis based on total machining cost per part was performed for the comparison of the economic viability between the different coating materials. Luo, X., Cheng, K., Holt, R. and Liu, X, et.al.[5] In this paper theoretical and experimental studies are carried out to investigate the intrinsic relationship between tool flank wear and operational conditions in metal cutting processes using carbide cutting inserts. A new flank wear rate model, which combines cutting mechanics simulation and an empirical model, is developed to predict tool flank wear land width. T.H. Mohammed, S.T. Montasser and B. Joachim [6] A set of experiments designed to begin the characterization of surface quality for the end-milling process have been performed. The objective of this study is to develop a better understanding of the effects of spindle speed, cutting feed rate and depth of cut on the surface roughness and to build a multiple regression model. Such an understanding can provide insight into the problems of controlling the finish of machined surfaces when the process parameters are adjusted to obtain a certain surface finish. M.Narasimha,K.Sridhar,R. Reji Kumar,Achamyeleh Aemro Kassie [7] The cutting tool is an important basic tool required in the machining process of a part in production. It not only performs the cutting action but helps in getting required surface finish and accuracy of the part. In order to perform these tasks the tool has to be strong enough to withstand wear resistance and serve for long period of time to produce more number of components with the same accuracy. Machining is important in metal manufacturing process to achieve near-net shape, good dimensional accuracy and for aesthetic requirements. In modern machining process and using the CNC machine tools the cutting tool will play a vital role in machining process and in improving the surface finish. İlhan Asiltürk,Harun Akkuş [8] This study focuses on optimizing turning parameters based on the Taguchi method to minimize surface roughness (Ra and Rz). Experiments have been conducted using the L9 orthogonal array in a CNC turning machine. Dry turning tests are carried out on hardened AISI 4140 (51 HRC) with coated carbide cutting tools. Each experiment is repeated three times and each test uses a new cutting insert to ensure accurate readings of the surface roughness. The statistical methods of signal to noise ratio (SNR) and the analysis of variance (ANOVA). . Choudhury, M.A. El-Baradie [9] This paper presents a study for the development of first- and second-order tool-life models at 95% confidence level for turning high strength steel. The tool-life models are developed in terms of cutting speed, feed rate, and depth of cut, using response surface methodology and design of experiment. The effects of the main cutting variables (cutting speed, feed, and depth of cut) on tool life have been investigated by the application of the factorial design method.

IV. Cutting Tool and Workpiece Material

In this experiment, we will take two tools tungsten carbide and cemented carbide which are normally used in the industry for turning operations in CNC Machine. Aluminium is chosen as the workpiece material because of its soft machining and is light in weight. Also the company required to perform the experiment on aluminium as most of their products are made of Aluminium.

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. In CNC machine, the turning process was completed on Aluminium (AL T6061) as workpiece and Tungsten Carbide and Cemented 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.

The Input Parameters of the experiments are :
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)	0.3	0.5	0.7

In this Experiment, the Input Parameters were Speed, Feed Rate, and Depth of Cut and its Output Parameters are Tool Life and Surface Roughness. The experiment is performed using Full Factorial of 3^K where K is 3 resulting into 27 reading for each tools.

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. Using the Full Factorial Method with 3 level and 3 variable i.e 3^K .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, calculation of tool life using Taylor's Tool Life Equation mentioned above is done and the best value for getting supreme tool life for both the tools and then the best value for the surface finish are taken from these experimented values. This process is followed in this experiment and result are tabulated below.

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)	Tool Life (Minutes)	Surface Roughness (µm)
1	800	0.15	0.3	53.55	1.800
2	800	0.15	0.5	42.45	1.668
3	800	0.15	0.7	36.43	1.933
4	800	0.2	0.3	31.74	2.805
5	800	0.2	0.5	25.16	2.590
6	800	0.2	0.7	21.59	2.599
7	800	0.25	0.3	21.15	3.809
8	800	0.25	0.5	16.77	2.813
9	800	0.25	0.7	14.39	2.824

10	1000	0.15	0.3	27.23	1.686
11	1000	0.15	0.5	21.58	1.455
12	1000	0.15	0.7	18.52	1.752
13	1000	0.2	0.3	16.13	2.534
14	1000	0.2	0.5	12.79	2.217
15	1000	0.2	0.7	10.98	2.562
16	1000	0.25	0.3	10.75	2.621
17	1000	0.25	0.5	8.52	2.929
18	1000	0.25	0.7	7.31	2.466
19	1200	0.15	0.3	15.67	1.646
20	1200	0.15	0.5	12.42	1.601
21	1200	0.15	0.7	10.66	1.778
22	1200	0.2	0.3	9.29	2.604
23	1200	0.2	0.5	7.36	2.439
24	1200	0.2	0.7	6.32	2.713
25	1200	0.25	0.3	6.19	3.223
26	1200	0.25	0.5	4.90	3.048
27	1200	0.25	0.7	4.21	3.037

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)	Tool Life (Minutes)	Surface Roughness (µm)
1	800	0.15	0.3	43.61	1.618
2	800	0.15	0.5	35.55	1.055
3	800	0.15	0.7	31.07	1.477
4	800	0.2	0.3	26.36	2.701
5	800	0.2	0.5	21.49	2.337
6	800	0.2	0.7	18.78	2.025
7	800	0.25	0.3	17.83	2.382
8	800	0.25	0.5	14.54	2.736
9	800	0.25	0.7	12.71	1.229
10	1000	0.15	0.3	14.28	1.684
11	1000	0.15	0.5	11.64	1.581

12	1000	0.15	0.7	10.18	1.523
13	1000	0.2	0.3	8.63	2.404
14	1000	0.2	0.5	7.04	1.579
15	1000	0.2	0.7	6.15	2.061
16	1000	0.25	0.3	5.84	2.523
17	1000	0.25	0.5	4.76	2.249
18	1000	0.25	0.7	4.16	2.322
19	1200	0.15	0.3	5.74	1.731
20	1200	0.15	0.5	4.68	1.618
21	1200	0.15	0.7	4.09	1.186
22	1200	0.2	0.3	3.47	1.237
23	1200	0.2	0.5	2.82	1.041
24	1200	0.2	0.7	2.47	1.594
25	1200	0.25	0.3	2.35	1.852
26	1200	0.25	0.5	1.91	3.089
27	1200	0.25	0.7	1.67	2.032

VI. CONCLUSION

In this work, aluminium is taken as a work material and Tungsten Carbide and Cemented Carbide as tools. By varying the different parameters like Speed, Feed Rate and depth of cut at different conditions the surface finish parameters were calculated. The results shown in table no 02 and 03, indicates that the max tool Life is obtained at a speed of 800 rpm, feed of 0.15 mm/rev and the depth of cut 0.3 for both Tungsten Carbide and Cemented Carbide tool. The results shown in table no 02, indicates that the good surface finish for Tungsten Carbide tool is obtained at a speed of 1000 rpm, feed of 0.15 mm/rev and the depth of cut 0.5. The results shown in table, indicates that the maximum Surface finish for Cemented Carbide tool at a speed of 800 rpm, feed of 0.15 mm/rev and the depth of cut 0.5.

By experimentation and calculations when represented graphically we can here by conclude that, the best Surface Roughness value and best Tool Life is achieved by the Tungsten Carbide tool in comparison of Cemented Carbide tool which depicts that the Tungsten Carbide tool is better in Metal Cutting than the Cemented Carbide tool.

VII. REFERENCES

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