EXPERIMENTAL EXAMINATION AND OPTIMIZATION ON QUALITY AND PRODUCTIVITY IN TURNING OPERATION

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ABSTRACT

The objective was to find the optimum machining parameters so as to minimize the input of the resources and to maximize the output of the process.The present work concerned an experimental study of turning on nickel-chromium – molybdenum case hardening alloy steel of AISI 4320 grade. The purpose of this thesis is to study the effect of speed, feed, and depth of cut on material removal rate, metal surface and tool wear in machining AISI 4320 alloy steel using tungsten carbide tipped cutting tool. Experiment were conducted on CNC lathe and the influence of cutting parameter was studied via analysis of variance (ANOVA) base on familiar approach. Based on the main effects plots obtain through Taguchi Analysis, a total of 18 tests were carried out, optimum level for MRR, Surface roughness and depth of cut were chosen from the three levels of cutting parameters considered. The choice of each parameter is place at three different levels, namely low, medium and high. Mathematical models were deduce by software design specialist in order to express the influence degree of the main cutting variables such as cutting speed, feed rate and depth of cut on MRR, SR and Flank wear. The results indicate that the cutting speed is the dominant factor affecting all three investigating parameters.

Keywords: *ANOVA, Optimization,MRR, SR, FW*

1. INTRODUTION-

Turning is an important machining process within which a single point cutting tool removes unwanted material from the surface of a rotating cylindrical work piece. Turning is employed to reduce the diameter of the work piece, typically to a nominative dimension, and to produce a smooth finish on the metal. Usually the work piece is turned in order that adjacent sections have different diameters. Turning is the machining operation that produces cylindrical components.

Yang W.H et al [1] confirmed that the Taguchi method provides a systematic and efficient methodology for the design optimization of the cutting parameters with far less effect than would be required for most optimization techniques. It has been shown that tool life and surface roughness can be improved significantly for turning operations. The confirmation experiments were conducted to verify the optimal cutting parameters. The improvement of tool life and surface roughness from the initial cutting parameters to the optimal cutting parameters is about 250%.

Nithyanandam J. et al [2] evalualted the result using coated carbide cutting inserts on turning of titanium alloy under different cutting parameters and investigated the result using Taguchi's orthogonal array (L09)

The feed rate is the dominant parameter for surface roughness followed by the cutting speed, and compared to other parameters the depth of cut shown minimal effect on surface roughness.

Dash, S.K [3] had done the experiment and analysis on the aluminum 6061 work piece with the carbide insert tool. Taguchi method can be efficiently used in off-line quality control in that the experimental design is combined with the quality loss. From the analysis it reveals that feed rate and cutting speed are the main factors affecting more the surface roughness and vibration. Principal cutting edge angle and depth of cut are the least affecting factors.

Sahin Y et al [11] represent the result on AISI 1050 steels using CBN/TiC cutting tools. Feed rate was the most powerful factor on surface roughness for all tools. In general, surface roughness of Ra, Rz and Rmax parameters decreased with decreasing main cutting parameters of V, f, d for CBN cutting tools.

Agrawalla Yashaswi [14] confirmed that the feed is the most significant factor affecting the surface roughness, closely followed by cutting speed and depth of cut, while the only significant factor affecting the tool wear was found to be the depth of cut.

2. WORK PIECE MATERIAL

The work piece used for the concluded experiment was AISI 4320 alloy steel. AISI 4320 is a nickel-chromium – molybdenum case – hardening steel that displays good strength, hardenability and toughness. It is an important engineering material employed in manufacturing of components in auto and aerospace industries..The work piece material used for the experiments is Alloy steel 4320 of standard dimensions was used for machining with 40 mm diameter, 100 mm long (6 specimen).

3. TOOL MATERIAL

Our Cutting tool is straight turning and grooving Tungsten Carbide tipped tool. . A **tipped tool** generally refers to any cutting tool where the cutting edge consists of a separate piece of material, either brazed, welded or clamped on to a separate body. Our Tipped tool is brazed with the body.Our Cutting tool is Neutral Hand with product code of 163 1616 K20.

Fig1: Cutting Tool

4. FACTOR AFFECTING THE QUALITY & PRODUCTIVITY

Increasing the productivity and the quality of the machined parts are the main challenges of manufacturing industries. Achievement of high quality & productivity, in terms of work piece dimensional accuracy, high surface finish, high production rate, Chip formation ,less tool wear on the cutting tools, economy of machining in terms of cost saving and increase the performance of the product with reduced environmental impact. Surface Roughness, MRR of the machined chip is an important quality measure in metal cutting, and it is important to monitor and control during the machining operation.

5. EXPERIMENTAL PROCEDURE

The experimental studies were carried out on an Ace designer LT-16 CNC lathe. The experiments were conducted under dry cutting conditions. The level of cutting parameter ranges and the initial parameter values were chosen from the manufacturer's handbook recommended for the tested material. These cutting parameters are shown in Table 1.

Table 1: Cutting Parameters

Parameters	Feed 1			Feed 2		
	0.08 mm/rev			0.16 mm/rev		
Cutting Speed (m/min)	130	180	230	130	180	230
Depth of Cut (mm)	2	8	16	2	8	16

The Taguchi method was used to reduce number of experiments. The design of experiments (DOE) and measured MRR, SR & TW values are shown in Table 2. Total 18 experiments were conducted with 6 specimens.

6. THE EXPERIMENT DEIGN USING THE TAGUCHI METHOD

The traditional experimental design methods are too Complex and difficult to use. Additionally, large numbers of experiments have to be carried out when the number of machining parameters increase. Therefore, the factors causing variations should be determined and checked under Laboratory conditions. These studies are considered under the scope of off-line quality improvement. The Taguchi method is an experimental design technique, which is useful in reducing the number of experiments dramatically by using orthogonal arrays and also tries to minimize effects of the factors out of control. The basic philosophy of the Taguchi method is to ensure quality in the design phase. The greatest advantages of the Taguchi method are to decrease the experimental time, to reduce the cost and to find out significant factors in a shorter time period.

7. Analyzing and Evaluating Results of the Experiment

Table 2- presents experimental results of MRR, SR and Tool Wear for various combinations of cutting regime parameters (cutting speed, feed rate and depth of cut) according to 18 experiments through Taguchi Analysis design.

Table 2: Obtained result

S. No.	Feed (mm/rev)	Cutting Speed (m/min)	Depth of cut (mm)	MRR (cm^3)	SR (µm)	Flank W. (mm)
1	0.08	130	2	2.34	6.93	0.421
2	0.08	130	8	2.65	7.02	0.384
3	0.08	130	16	3.01	6.67	0.560
4	0.08	180	2	4.44	5.49	0.585
5	0.08	180	8	5.11	6.59	0.435
6	0.08	180	16	4.89	4.63	0.590
7	0.08	230	2	6.01	4.25	0.243
8	0.08	230	8	6.55	4.34	0.285
9	0.08	230	16	6.87	3.65	0.352
10	0.16	130	2	3.02	6.65	0.755

11	0.16	130	8	3.11	6.88	0.822
12	0.16	130	16	4.01	6.93	0.802
13	0.16	180	2	5.32	5.16	0.464
14	0.16	180	8	5.42	6.30	0.500
15	0.16	180	16	5.98	6.40	0.474
16	0.16	230	2	6.74	6.63	0.400
17	0.16	230	8	5.76	5.77	0.394
18	0.16	230	16	6.72	6.91	0.358

The main effects plots for the Material Removal Rate (MRR), surface roughness (SR) and the flank wear (FW) are shown in Fig 3

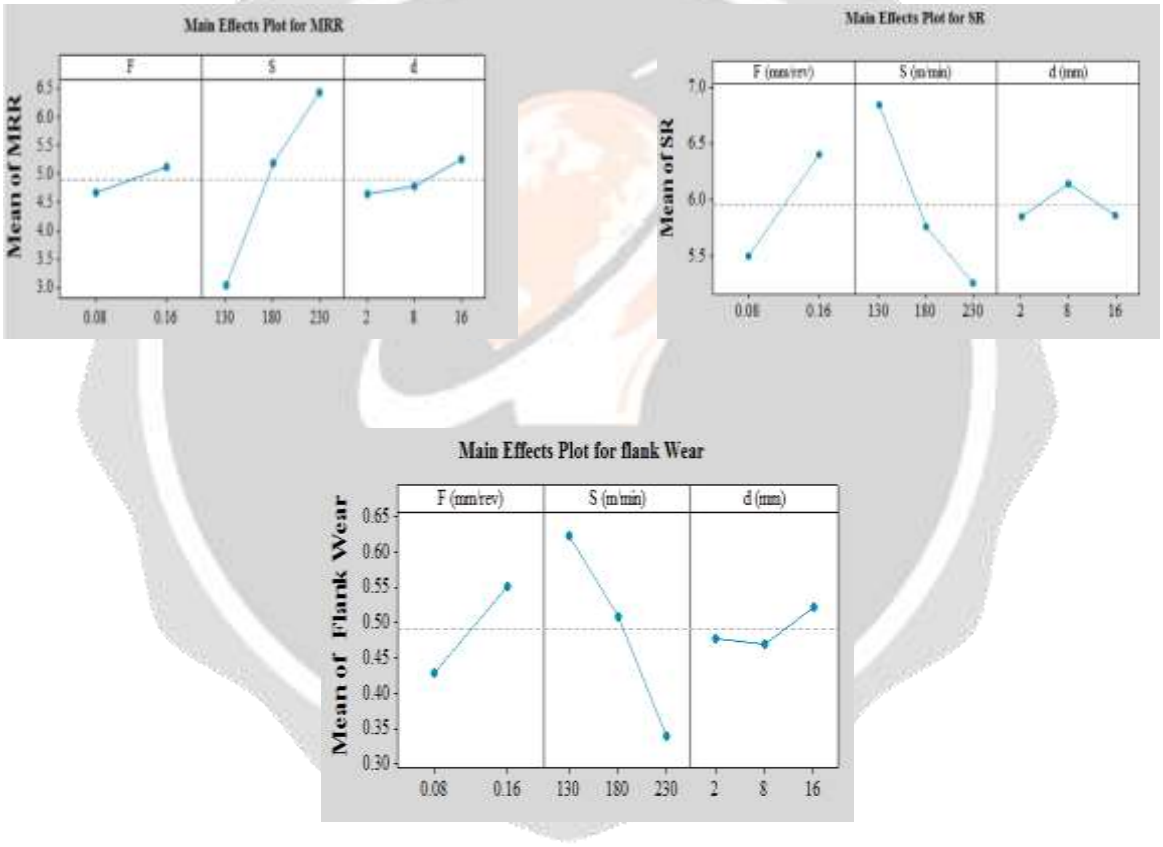

Fig 3: Main Effects plots for MRR, SR and Flank wear

7. CONCLUSION

Based on the experiment and ANOVA results presented and discussed, the following conclusions can be drawn on the effect of cutting speed, feed and depth of cut on the performance of Tungsten carbide tipped tools when turning AISI 4320 steel:

- The important factor affecting the MRR (Material Removal Rate) is cutting speed then depth of cut then feed rate. The optimum condition for best MRR is f=0.08rev/min, S=230 m/min and d=16 mm.

- For Surface roughness (SR) the most important factor are as follows: Cutting Speed, feed rate and depth of cut. The optimum condition for best SR is f=0.08rev/min, S=230 m/min and d=16 mm.
- Observation of Flank wear (FW) during experiment we find that the most affecting factors are Cutting Speed closely followed by feed rate then depth of cut. The optimum condition for best Tool wear is f=0.08 rev/min, S=230 m/min and d=2 mm.

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