Analysis and Optimisation Of Aisi1030 Steel Turning Parameter Using Doe

Hari Prasath. R[1], Dr. M. Jeya kumar[2]
Assistant Professor, Department of Mechanical Engineering, Christ The king Engineering college ,Coimbatore
Professor, Department of Mechanical Engineering , Christ The king Engineering college,coimbatore

***Abstract*- the AISI 1030 steel used in stressed applications such as couplings, crankshafts, axles, bolts, rods, gears, forgings, tubes and plates. This project deals with the analysis of significant effect of Speed, feed rate and rake angle on cutting forces, tool wear by simulation of AISI 1030 steel using DEFORM 3D.For this series of simulation trial is conducted based on Design of Experiments and optimization analysis performed using Taguchi.**
Keywords: AISI 1030 steel, Design of Experiments, Deform 3D, Taguchi analysis

I. INTRODUCTION

During the last two decades, there has been a considerable industrial interest in the machining of hard to cut. With the advancement of science and technology, there is a need for materials of high hardness and shear strength in the market. Many manufacturing processes involve some aspects of the operations, in which there is the need to estimate quantitatively the technological performance of machining operations such as tool life, strength, power and surface finish. The Taguchi experimental design method is a well-known, unique and powerful technique for product or process quality improvement (Roy, 1999). It is widely used for 143 analysis of experiment and product or process optimization. Taguchi has developed a methodology for the application of factorial design experiments that has taken the design of experiments from the exclusive world of the statistician and brought it more fully into the world of manufacturing. Hence to analyse the effect of cutting force ,tool wear the no of trials is selected based on Taguchi design.

II. METHODOLOGY FLOW

Material Selection: AISI1030 Steel (Work Piece)

↓

Work piece dimension: dia32m, length 100mm

↓

Tool insert: carbide tool insert

↓

Analysis in DEFORM 3D

↓

Optimisation using ANOVA

III. ESIGNOFEXPERIMENTS (DOE)

The aim of the experiments was to analyze the effect of cutting parameters on the tool wear and work piece AISI1030 Steel. The experiments were planned using Taguchi's orthogonal array in the design of experiments which help in reducing the number of experiments. Analysis were conducted according to a three level, L9 array presented in the table below

Machining parameters				
Code	**Levels**	**Speed (rpm) A**	**Feed (mm/rev) B**	**Back Rake angle (deg) C**
1	Low	400	0.05	5.00
2	Medium	800	0.12	7.00
3	High	1200	0.18	10.00

3.1TAGUCHI L9 ARRAY:

Tria l no	**Spindle speed (rpm)**	**Feed rate (mm/rev)**	**Back rake angle(deg)**
1	400	0.05	5.00
2	400	0.12	7.00
3	400	0.18	10.00
4	800	0.05	5.00
5	800	0.12	7.00
6	800	0.18	10.00
7	1200	0.05	5.00
8	1200	0.12	7.00
9	1200	0.18	10.00

IV. ANALYSIS IN DEFORMS 3D

The interfaces between the work piece and tool is represented in terms of x,y and z directions in Deform 3D.The interfacing of work piece and tool is created after meshing in Deform 3D. The interfacing is very important in order to carry out the machining operation with proper speed, feed and depth of cut. In the 'Tool Mesh Generation' menu the size ratio as 4, and using 45000 tetrahedral elements generated mesh for the carbide insert. The tool and work piece interface are shown in figure below.

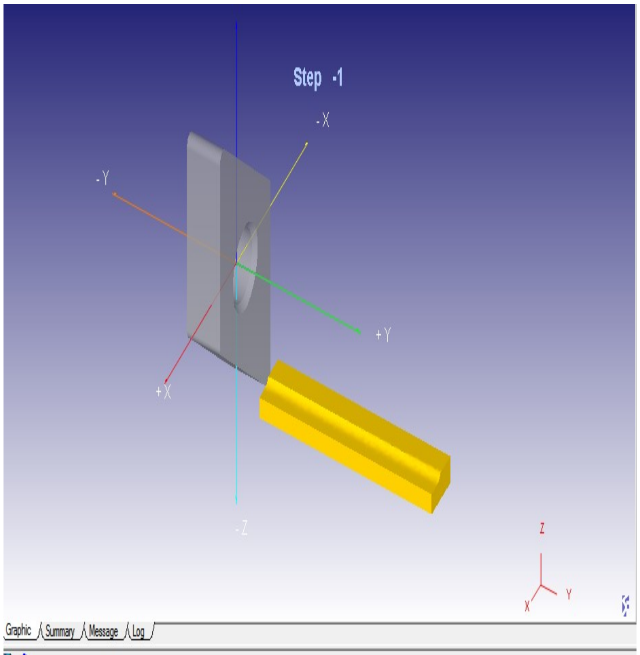
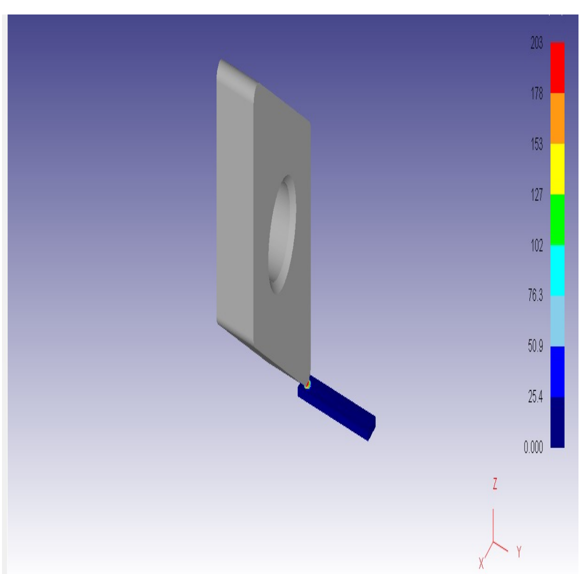


Figure 4.1: Tool and work piece interface

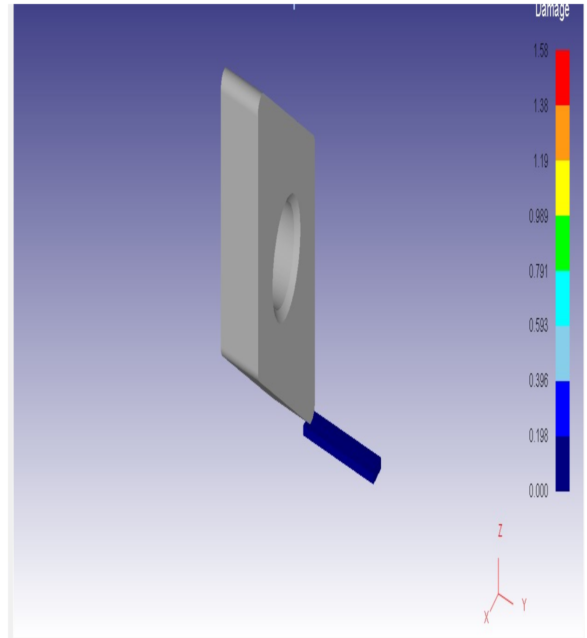
4.1PROCESS CONDITIONS AND SIMULATION:

The process conditions are selected from the deform 3D material library and according to the Taguchi L9 simulation conducted for trial run order. The generated output results are the cutting force and tool wear. The generated results of cutting force and tool wear for trial 3 with speed 400rpm,feed = 0.18 mm/rev, back rake angle 10o.Similarly the results for cutting force, tool wear are generated from trial 1 to trial 9 which is considered for the optimization.

4.2 DEFORM 3D RESULT FOR CUTTING FORCE:



4.3DEFORM 3D RESULT FOR TOOLWEAR:



4.4 SIMULATION RESULTS:

The results obtained for the cutting force and tool wear in Deform 3D is tabulated below. The input parameters are speed, feed and back rake angle. The output response is cutting force and tool wear. The result obtained for the cutting force is in Newton (N) S.I Unit. Similarly the result obtained for the tool wear is in mother simulated analytical results in Deform 3D are tabulated as follows for the L9 trials.

4.4.1 Simulation Results

TRIAL NO	SPEED (RPM)	FEED (mm/rv)	BACK RAKE ANGLE (deg)	CUTTING FORCE (N)	TOOL WEAR (mm)
1	400	0.05	5.00	105	2.62
2	400	0.12	7.00	217	2.64
3	400	0.18	10.00	203	1.58
4	800	0.05	5.00	201	1.18
5	800	0.12	7.00	207	0.85
6	800	0.18	10.00	243	1.74
7	1200	0.05	5.00	166	1.36
8	1200	0.12	7.00	213	3.06
9	1200	0.18	10.00	230	1.78

V. ANALYSISOF VARIANCE (ANOVA)

In order to know the significance of parameters affecting quality characteristics, the Analysis of variance (ANOVA) is performed. The S/N ratio is also represented in the graph below. The mean effective plots for the cutting force, tool wear are represented graphically using ANOVA. The parameters speed, feed and back rake angle mentioned as A, B, C under 3 level using taguchi designs

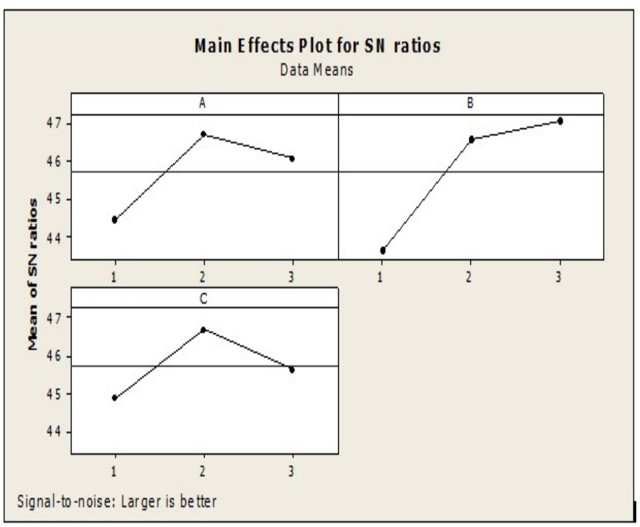
5.1 GRAPHICAL PLOT OF S/N RATIO FOR SIMULATED CUTTING FORCE:

The optimal cutting force conditions are analyzed by Taguchi's the larger the better quality characteristic (S/N ratio) for cutting force. S/N (dB) ratio is calculated using the following equation:

$$S/N = -10*\log (S (1/Y2)/n)$$

Where Y = responses for the given factor level combination and n = number of responses in the factor level combination.

The S/N ratio graph for signal to noise ratio is shown below in figure



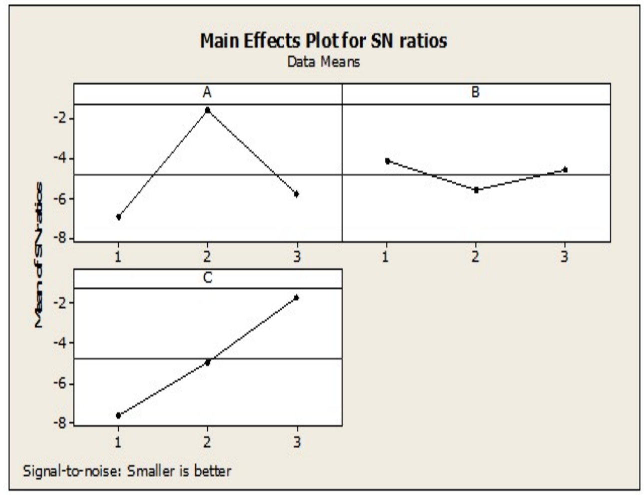
Where A-Speed-Feed-C-Back rake angle

5.2GRAPHICAL PLOT OF S/N RATIO FOR SIMULATED CUTTING FORCE:

The performances of optimal tool wear conditions are analyzed by Taguchi's the 'Smaller the better' quality characteristic (S/N ratio) for cutting force. The signal-to-noise (S/N) ratio is calculated for each factor level combination. The formula for the smaller-is-better S/N ratio using base 10 logs is:

$$S/N = -10*\log(S(Y2)/n)$$

Where Y = responses for the given factor level combination and n = number of responses in the factor level. The graphical plot of cutting force is shown in figure below



Where A-Speed, B-Feed C-Back rake angle

VI. RESULT AND DISCUSSIONS:

The simulation of AISI 1030 steel with carbide tool insert has been done. The results obtained for cutting force and the tool wear is optimized by performing ANOVA based on the S/N ratio. From the S/N ratio graphical plot the maximum cutting force is generated shows that the feed rate plays a significant factor. Similarly for minimum tool wear back rake angle plays significant factor.

FUTURE SCOPE

The future work may include the analysis of material removal rate, velocity and temperature during machining .The analysis and optimization may carried out by using ANOVA (Analysis of variance) for the further process improvement.

REFERENCES

[1] Aggarwal A., Singh H., Kumar P. and Singh M. Optimizing power consumption for CNCturned parts using response surface methodology and Taguchi's technique – a comparative

[2] Analysis. Journal of Material Processing Technology, 2008; 200(1-3): 373-384.

[3] Akhyar G., Haron C.H.C. and Ghani J.A. Application of Taguchi method in the optimizationof turning parameters for surface roughness.InternationalJournal of Science Engineering and Technology, 2008; 1(3): 1379-1385.

[4] Aslan E., Camuscu N. and Birgoren B. Design optimization of cutting parameters whenturning hardened AISI 4140 steel (63 HRC) with Al2O3+TiCN mixed ceramic tool Journal Mater. Des, 2007; 28: 1618–1622.

[5] Davim J.P. and Figueira L. Machinability evaluation in hard turning of cold work tool steel(D2) with ceramic tools using statistical techniques. Journal of Materials and Design,2007; 28: 1186–1191.

[6] Hamdan A., Sarhan Ahmed A.D., and Hamdi M.A. Optimization method of the machiningparameters in high speed machining of stainless steel using coated carbide tool for best surface finish. International Journal Adv Manufacturing Technology, 2012; 58: 81–91..