International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 3, No. 4, October 2014

Research Paper

OPTIMIZATION OF TURNING PARAMETERS OF OHNS (AISI O-1) STEEL RODS USING TAGUCHI METHODOLOGY

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Oil Hardened Non Shrinkable steel (OHNS) rods finding many applications like Lay shafts, Wheel axle, gears and Fasteners Due their high hardness, strength and weight ratio. Optimum machining parameters of turning operations are greatly influenced with concern along with manufacturing environment. In this experimental work turning parameters on OHNS with different cutting parameters like cutting speed, feed and depth of cut greatly influenced by response parameters like surface roughness and metal removal rate. Mainly surface roughness where investigated employing L9 orthogonal array using taguchi's design of experiments. The different cutting parameters of OHNS of turning parameters and optimized by S/N ratio and analyzed by Analysis of variance (ANOVA's).

Keywords: OHNS, Turning parameters, Taguchi, Surface roughness, MRR, S/N ratio, ANOVA

INTRODUCTION

Turning is basic metal removal process which machining with high degree of accuracy of cylindrical workpiece. Ersan Aslam *et al.* (2007) has shown that the optimized machining parameters while machining A1S1 140 steel with ceramic tool & shown that cutting speed, feed rake and depth of cut inter actions have significant influence on surface roughness. Matsumara *et al.* (2004) express a note on the determination of optimal cutting conditions for surface finish obtained in turning using design of experiments for carbide coated tool turning tool. Matsumu Ra *et al.* (2004) performed turning operation and study the machinability of steel and give key note to determination of optimal cutting conditions for surface finish obtained in turning using design of experiments for carbide coated. Sutter (2005) gives analyzing the chip formation and

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chip geometrics' during high speed machining for orthogonal cutting conditions. Obvious that achievement of proper surface finish of the manufactured parts are desirable and essential in some applications. It has been seen that Lin (2008) have studied the study of high speed fine turning of austenitic stainless steel. Sze-Wei Gan *et al.* (2007) have discussed a fine tool servo system for global position error compensation for a miniature ultra-precision lathe. Vikram Kumar and Ramamoorthy (2007) have dealt with Performance of coated tools during hard turning under minimum fluid application. Further Sarma and Dixit (2007) have compared the dry and air-cooled turning of grey cast iron with mixed oxide ceramic tool. Gokkaya Hasan and Nalbant Muammer (2007) have studied The effects of cutting tool geometry and processing parameters on the surface roughness of AISI 1030 steel. However, Isik and Yahya (2007) have investigated the machinability of tool steels in turning operations.

OHNS STEEL

OHNS steel refers to a variety of carbon and alloy steels that are particularly well-suited to be made into tools. Their suitability comes from their distinctive hardness, resistance to abrasion, their ability to hold a cutting edge, and/or their resistance to deformation at elevated temperatures (red-hardness). Tool steel is generally used in a heat-treated state. Many high carbon tool steels are also more resistant to corrosion due to their higher ratios of elements such as vanadium and niobium. With carbon content between 0.7% and 1.5%, tool steels are manufactured under carefully controlled conditions to produce the required quality. The manganese content is often kept low to minimize the possibility of cracking during water quenching. However, proper heat treating of these steels is important for adequate performance, and there are many suppliers who provide tooling blanks intended for oil quenching.

Table 1: Chemical Composition of OHNS Steel

C	Mn	Cr	W	V
0.95	1.15	0.5	0.5	0.2

Table 2: Mechanical Properties of OHNS Steel

Max. Stress	Yield Stress	Proof Stress	Elongation	Impact Strength	Hardness Value
950 N/mm^2	465 N/mm^2	480 N/mm^2	10%	25j	288 Brinell

PROBLEM IDENTIFICATION

The identification of turning problem for OHNS Steel rods which cannot be tackled using conventional technique because of following problems occurs in turning process.

- High surface roughness.
- Difficult to achieve Close tolerance
- Machining distortion.
- Poor Chip Breaking.
- Need more cutting pressure for machining.
- Need high hardness cutting tool for machining.

RESULTS AND DISCUSSION

After conducting the experiments of milling operation on OHNS Steel rods (diameter 22 and 60 mm length) of surface roughness values and metal removal rate are given.

Figure 1: Schublin CNC Machine

Figure 2: cBN Tool Insert

Figure 3: OHNS Steel Rods

Figure 4: Surface Roughness Tester

Surface Roughness

- Spindle speed is a dominating parameter of surface roughness of turning process.
- The optimum parameter of turning operation of OHNS Steel plates were spindle speed 1500 RPM, feed rate 0.06 mm and depth of cut 1.
- However OHNS Steel plate having good machinability characteristic and Produce reasonable surface finish.

Table 3: Turning Parameters of Surface Roughness of OHNS Rods

Test No.	Cutting Speed (m/min)	Feed Rate (mm/rev)	Depth of Cut (mm)	Surface Roughness (micron)
1	1000	0.06	0.5	0.96
2	1000	0.05	0.7	0.92
3	1000	0.04	1	1.12
4	1250	0.06	0.7	0.89
5	1250	0.05	1	0.90
6	1250	0.04	0.5	0.94
7	1500	0.06	1	0.62
8	1500	0.05	0.5	0.82
9	1500	0.04	0.7	0.94

Table 4: Signal to Noise Ratios of Surface Roughness Values of OHNS Rods (Smaller is Better)

Level	Cutting Speed	Feed Rate	Depth of Cut
1	0.03149	1.83965	0.87191
2	0.82160	1.12104	0.75796
3	2.13778	0.03018	1.36099
Delta	2.13778	0.03018	1.36099
Rank	1	2	3

- Obtained Good surface integrity and minimum wear occur during turning operation of OHNS Steel rods.
- During turning process all parameters are interact and dependant able in turning operation.

Metal Removal Rate

- Feed rate is a dominating parameter of metal removal rate of turning operation
- The optimum parameter for Metal removal rate of turning operation were1250 RPM of spindle speed,0.05 mm/rev of feed rate and 1 mm of depth of cut.

Table 5: Turning Parameters for Metal Removal Rate of OHNS Rods

Test No.	Cutting Speed (m/min)	Feed Rate (mm/rev)	Depth of Cut (mm)	MRR (mm^3/min)
1	1000	0.06	0.5	2.35
2	1000	0.05	0.7	2.75
3	1000	0.04	1	3.14
4	1250	0.06	0.7	3.29
5	1250	0.05	1	3.92
6	1250	0.04	0.5	1.57
7	1500	0.06	1	4.71
8	1500	0.05	0.5	1.96
9	1500	0.04	0.7	2.19

Table 6: S/N Ratio for Metal Removal Rate of OHNS Rods

Level	Spindle Speed	Feed Rate	Depth of Cut
1	8.716	10.409	5.728
2	8.709	8.832	8.646
3	8.705	6.888	11.755
Delta	0.011	3.520	6.027
Rank	3	2	1

Figure 5: S/N Ratio for Metal Removal Rate

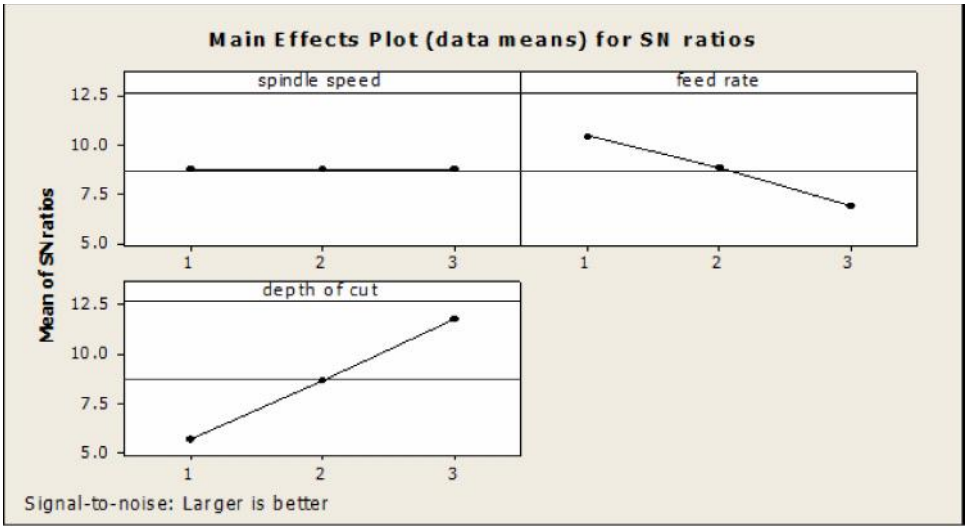


Figure 6: Interaction Plot for Metal Removal Rate

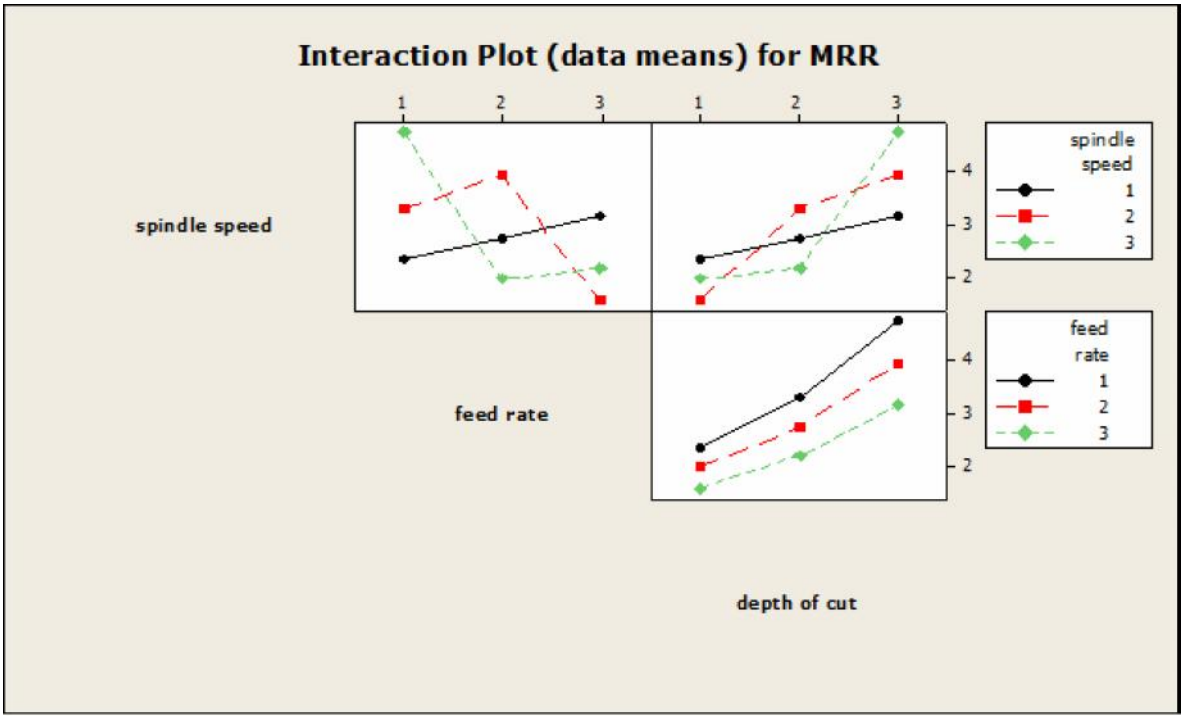
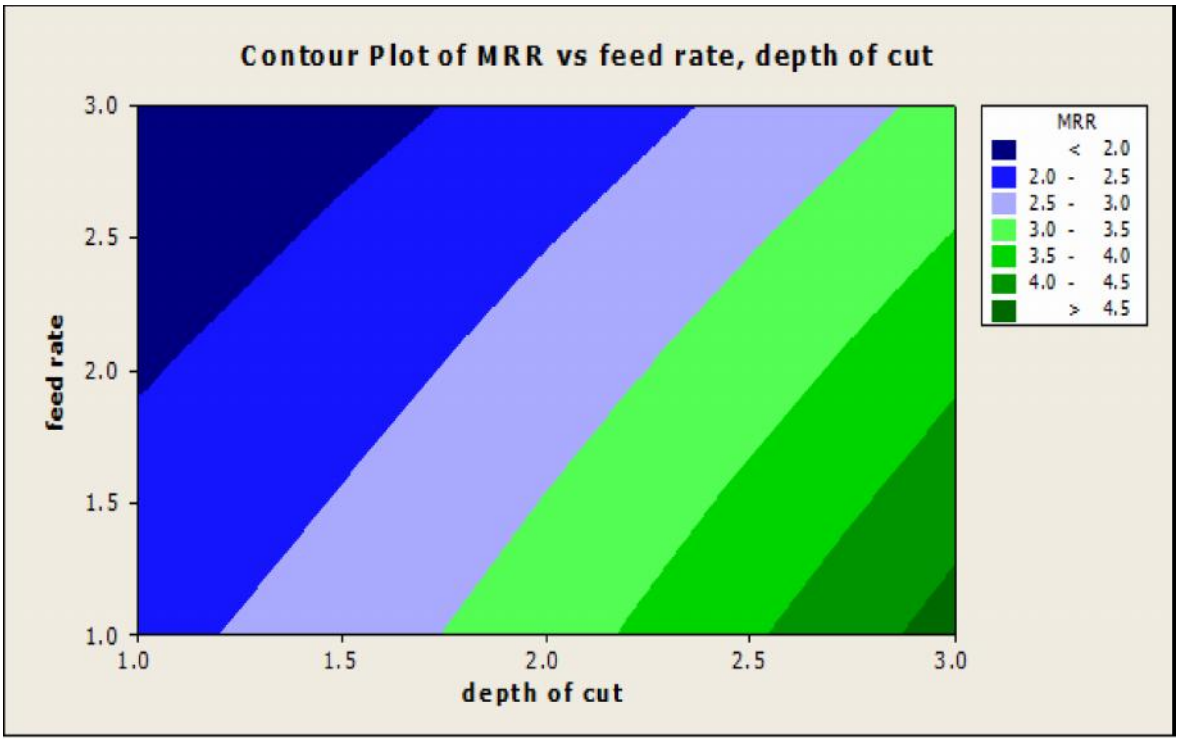


Figure 7: Contour Plot for MRR



- However OHNS Steel rods having good machinability characteristic and Produce reasonable surface finish.
- The large metal removal rate of OHNS Steel in turning operation is 3.92 mm^3/sec.
- The metal removal rate is dependant parameter of turning operation.

From Table 5 indicate the optimum parameter of metal removal rate of OHNS Steel rods were spindle speed of 1250 RPM, feed rate,0.05 mm/rev and depth of cut 1 mm.

From Table 6 shows feed rate is a dominating parameter of Metal removal rate in OHNS Steel in turning process.

The Figure 7 shows the graphical representation and 3 dimensional relation between turning parameters with metal removal rate of OHNS Steel plates and indicate the larger metal removal rate are 2^{nd} level of feed rate and 3^{rd} level of depth of cut.

CONCLUSION

After conducting the experiments of turning parameters on OHNS steel rods and optimum parameters of surface roughness and metal removal rate are given below:

- Spindle speed is a dominating parameter of surface roughness of turning process.
- The optimum parameter of turning operation of OHNS Steel plates were spindle speed 1500 RPM, feed rate 0.06 mm and depth of cut 1 mm.
- However OHNS Steel plate having good machinability characteristic and Produce reasonable surface finish.
- Spindle speed is a dominating parameter of machining time turning process.
- The optimum parameter of Machining time of turning operation of OHNS Steel plates were 1500 RPM of spindle speed, 0.04 mm/rev of Feed rate and 0.7 mm of Depth of cut.
- Feed rate is a dominating parameter of metal removal rate of turning operation.
- The optimum parameter for Metal removal rate of turning operation were 1250 RPM, 0.05 mm/rev of Feed and 1 mm of depth of cut.
- However metal removal rate is a dependant parameter of turning operation.

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