Mayourshikha Pancholi. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 11, Issue 6, (Series-II) June 2021, pp. 42-50

RESEARCH ARTICLE OPEN ACCESS

Improve Machine Tool Life during Hot Machining Process By Using Taguchi Method

Mayourshikha Pancholi (Bhatnagar)
Sr. Lecturer in Manufacturing Engineering Department, Govt. Polytechnic College, Agar Malwa, M.P., India

ABSTRACT
This project attempts on optimizing the cutting condition and Tool Life obtained in hot machining of **hard Material** with Hot machining experiments were performed on lathe machine using carbide tool insert. Taguchi designs provide a powerful and efficient method for designing products that operate consistently and optimally over a variety of conditions. , the primary goal is to find factor settings that minimize response variation, while adjusting (or keeping) the process on target. Experiments were conducted based on Taguchi L9 orthogonal array. The statistical method of signal-to-noise (S/N) ratio and were employed to investigate the optimum process parameters like speed feed, depth of cut and work piece temperature and their effect on the performance characteristics i.e., tool life . The results of the study indicate that feed rate has the most significant effect on tool life. Cutting speed and feed rate has the most significant effect on material tool life.
Keywords *– Taguchi , Hot machining, Lathe machine, Tool life, Taguchi, carbide tool, signal-to-noise*

Date of Submission: 06-06-2021 Date of Acceptance: 20-06-2021

I. INTRODUCTION

Presentation High quality work materials have tremendous applications in the field of aeronautics, nuclear, biomedical, vehicle, etc It is an inciting task to machine these excellent materials. Notwithstanding the way that there have been various techniques progressed to machine such materials, such strategies are expensive and extravagant cutting devices are expected to machine those materials. Hot machining is where work piece must be warmed underneath recrystallization temperature anyway on occasion it has been moreover warmed above recrystallization temperature. High Manganese steel and other high wear resistance exacerbates which are commonly used for various applications are having high strain setting property. The hot machining movement relies upon the molding wonder about the locale of shear zone (misshapening zone). Unwinding of workpiece at the misshapening zone makes the material malleable (lessens shear quality) which assists with diminishing cutting power and addition in surface honesty. Warming gas fire utilized for activity ought to be in a steady way, which conveys same temperature all through the workpiece material. Warming should be possible earlier or on the other hand at the hour of machining. The blowpipe course should be opposite to gadget holder for better warming. There are many controlling components, for instance, workpiece temperature, cutting speed, feed rate, significance of cut, nose range, cutting time, etc which contribute on the exhibition attributes. The issue emerges might be because of the utilization of off base degrees of control boundaries, for example, feed, profundity of cut and cutting speed, and so on Apparatus life and force utilization have a lot of commitment in cost of assembling. Surface completion is the most wanted trademark for good execution of item. Chip decrease coefficient is additionally a successful measure which assesses the machinability. The suitable determination of machining boundaries must be made to accomplish the above machinability models.

The warmth necessities for this cycle ought to fulfill the accompanying conditions

1. Warmth input rate should be exceptionally high with the end goal that the work piece gets warmed up in a very short time.
2. The warmth produced should warm just the shear zone.
3. Consistent temperatures over a wide reach ought to be created.
4. The establishment cost and working expense ought to be less. In light of the above prerequisites Oxy Acetylene gas fire was utilized in the led analyses of Hot Machining

II. TAGUCHI METHOD

Taguchi methodology is an astonishing resource for the arrangement of first class systems. It gives a fundamental, successful and effective approach to manage improve plan for execution, quality and cost. To look at effect of four cycle limits like speed, feed, significance of cut, workpiece temperature on two critical execution characteristics surface obnoxiousness, MRR. Considering the degree of chance of cycle limits, L18 even group is picked. In like manner, 18 assessments were finished to consider the effect of machining measure limits on execution characteristics. In all tests surface cruelty was assessed by Mitutuyo surface analyzer and metal removal rate is dictated by the extent of weight decrease of the workpiece to the time. The model was weighed when machining using modernized measuring machine. The time was assessed using an automated stopwatch. Parametric arrangement study incorporates control and fuss factors. Extent of correspondences between these components as to healthiness is signal-to-uproar (S/N) extent.

III. SIGNAL-TO- NOISE RATIO:

The control factor that may add to decrease variety can be immediately recognized by taking a gander at the measure of variety present as reaction. Taguchi has made a change of the redundancy information to another worth which is reaction proportion of the variety present. The change is signal-to-commotion ratio(S/N).There are three S/N proportions accessible relying on the sort of attributes.

1) LOWER IS BETTER:
$(S/N)LB = -10 \log (1/r\ \Sigma\ yi^2)$
Where,
r = Number of tests in a single trial.
2) NOMINAL IS BETTER:
$(S/N)NB1 = -10 \log Ve$
$(S/N)NB2 = 10 \log ((V_m - V_e)/r\ V_e)$
3) HIGHER IS BETTER:
$(S/N)HB = -10 \log (1/r\ \Sigma\ yi^2)$
Where, yi = each observed value.

IV. EXPERIMENTAL

4.1 HOT MACHINING OF "HIGH MANGANESE STEEL" BY TAGUCHI'S L9

4..1.1 DESIGN WITH TOOL LIFE AS RESPONSE:

Instrument life is characterized as the time up to which the apparatus can appropriately machine the given work piece. For this situation device life is considered as the time up to which the flank wear esteem arrives at 0.4 mm

4.2 TOOL LIFE AT FIRST RUN OF TAGUCHI'S L9 DESIGN:

Prior to beginning the trial the instrument is crushed appropriately making the flank wear zero. The cutting pace, feed, profundity of slice and temperature are set to the fitting indicates values. The instrument is eliminated after like clockwork and the flank wear is estimated in apparatus creator's magnifying lens. This cycle is proceeded till instrument wear arrives at 0.6 mm. A chart is plotted among time and flank wear. The perusing in X-hub (Time) relating to the flank wear of 0.4 mm is the device life for the given machining boundaries.

4.2.1 FIRST RUN:

Cutting Speed = 20.55 m/min
Feed = 0.05 mm/rev
Depth of Cut = 0.5 mm
Temperature = 600 degrees

CALCULATION OF CUTTING FORCE:
Average power required = 25.21 Watt
Diameter of the work piece= 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*250)/60 = 0.54
Therefore cutting force= power/cutting velocity = 25.21/0.54 = 46.68 N
Cutting force = 46.68 N

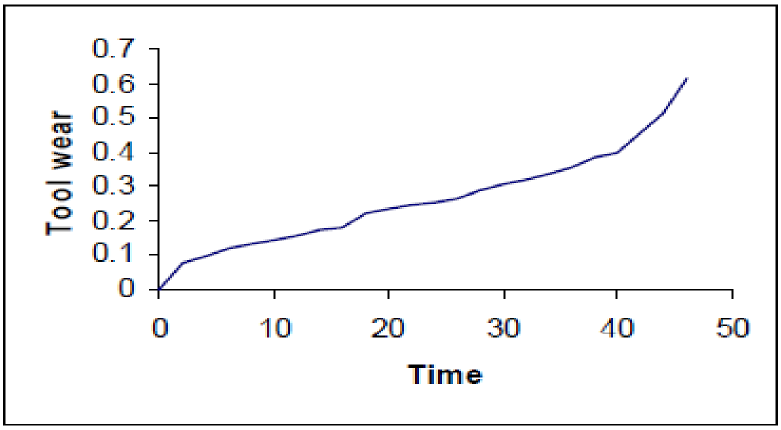

Figure 4.1: Tool wears Vs Time

From graph,
Tool Life = 40 min

4.2.2 SECOND RUN:
Cutting Speed = 20.55 m/min
Feed = 0.1mm/rev
Depth of Cut = 1.0 mm
Temperature = 400 degrees

CALCULATION OF CUTTING FORCE:
Average power required = 25.416 W att
Diameter of the work piece= 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*250)/60 = 0.54
Therefore cutting force= power/cutting velocity = 25.415/0.54 = 47.06 N
Cutting force =47.06N

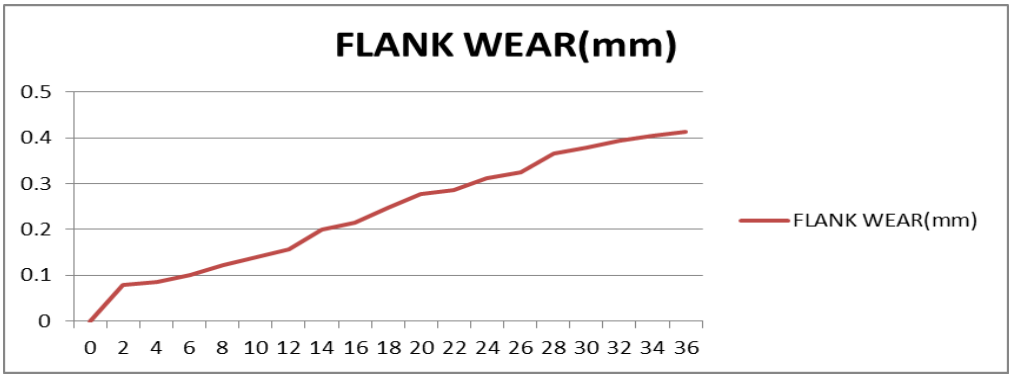

Figure 4.2: Flank wear Vs Time

From graph,
Tool Life = 34 min

4.2.3 THIRD RUN:
Cutting Speed = 20.55 m/min
Feed = 0.15 mm/rev
Depth of Cut = 1.5 mm
Temperature = 300 degrees

CALCULATION OF CUTTING FORCE:
Average power required = 26.84 Watt
Diameter of the work piece= 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*250)/60 = 0.54
Therefore cutting force= power/cutting velocity = 26.84/0.54 = 49.703 N
Cutting force = 49.703 N

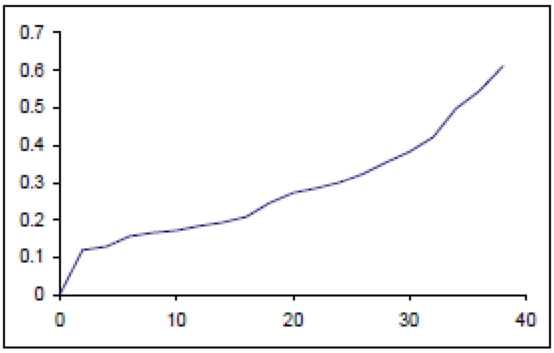

Figure 4.3: Tool wear Vs Time

Tool Life = 31 minutes

4..2.4 FOURTH RUN:
Cutting Speed = 33.58 m/min
Feed = 0.05 mm/rev
Depth of Cut = 1.0 mm
Temperature = 300 degrees

CALCULATION OF CUTTING FORCE:
Average power required = 25.78 Watt
Diameter of the work piece= 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*350)/60 = 0.760
Therefore cutting force = power/cutting velocity = 25.78/0.760 = 33.92 N
Cutting force =33.92 N

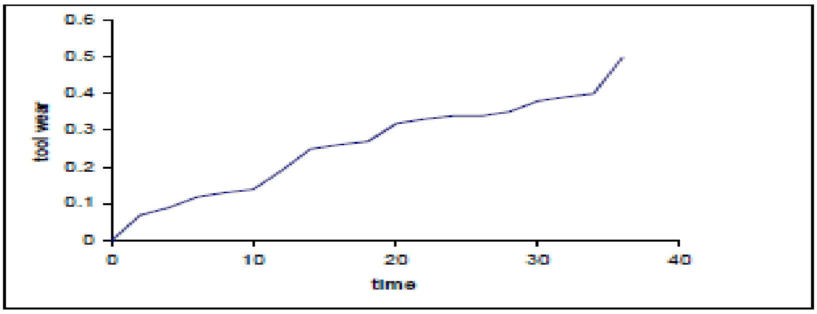

Figure 4.4: Tool wear Vs Time

From graph,
Tool Life = 36 minutes

4.2.5 FIFTH RUN:
Cutting Speed = 33.58 m/min
Feed = 0.1 mm/rev
Depth of Cut = 1.5 mm
Temperature = 600 degree

5.2.5.1 CALCULATION OF CUTTING FORCE:
Average power required= 30 Watt
Diameter of the work piece = 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*350)/60 = 0.760
Therefore cutting force= power/cutting velocity = 30/0.760 = 39.47 N
Cutting force =39.47 N

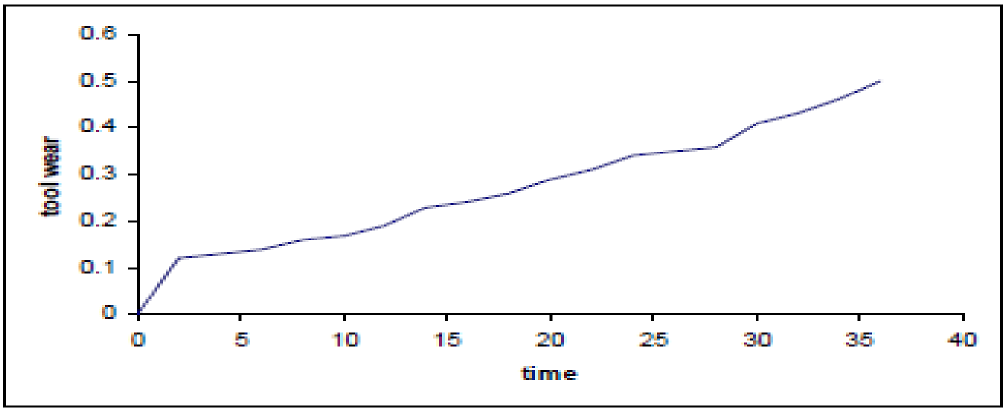

Figure 4.5: Tool wear Vs Time

From graph,
Tool Life = 37 minutes

4.2.6 SIXTH RUN:
Cutting Speed = 33.58 m/min
Feed = 0.15 mm/rev
Depth of Cut = 0.5 mm
Temperature = 400 degree

CALCULATION OF CUTTING FORCE:
Average power required = 30 Watt
Diameter of the work piece = 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*350)/60 = 0.760
Therefore cutting force= power/cutting velocity = 30/0.760 = 39.47 N
Cutting force = 39.47 N

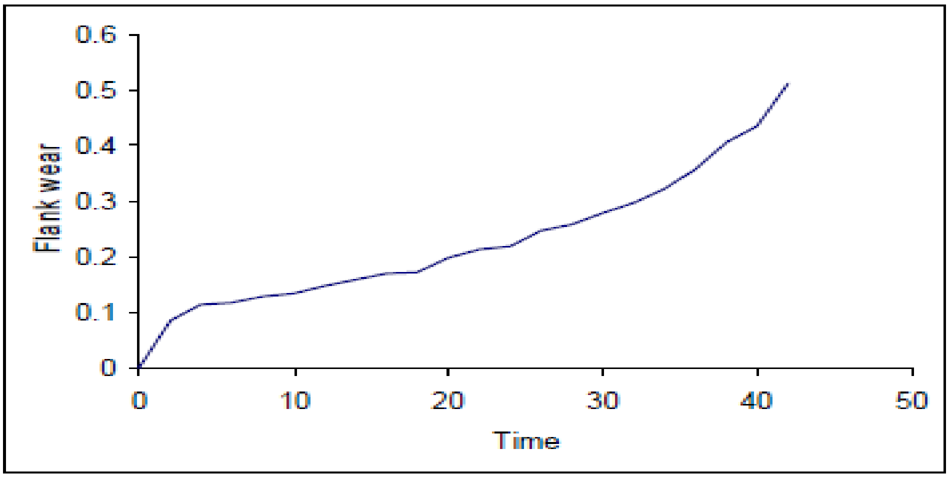

Figure 4.6: Tool wear Vs Time

From graph,
Tool Life = 38 minutes

4.2.7 SEVENTH RUN:
Cutting Speed = 54.73 m/min
Feed = 0.05 mm/rev
Depth of Cut = 1.5 mm
Temperature = 400 degrees

CALCULATION OF CUTTING FORCE:
Average power required = 37.61 Watt
Diameter of the work piece= 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*450)/60 = 0.977
Therefore cutting force= power/cutting velocity = 37.61 /0.977= 38.49 N
Cutting force = 38.49 N

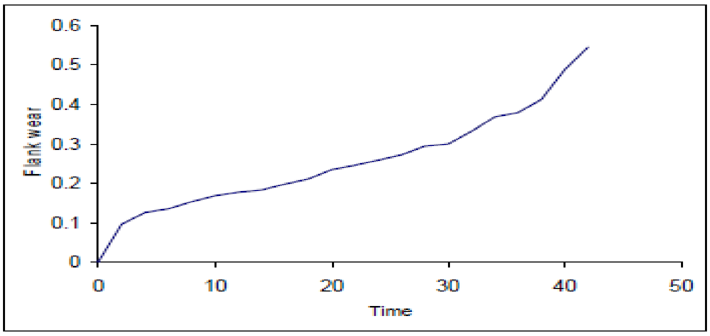

Figure 4.7: Tool wear Vs Time

From graph,
Tool Life = 34 minutes

4.2.8 EIGTH RUN:

Cutting Speed = 55.73 m/min
Feed = 0.1 mm/rev
Depth of Cut = 0.5 mm
Temperature = 300 degrees

CALCULATION OF CUTTING FORCE:

Average power required = 39Watt
Diameter of the work piece = 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*450) /60 = 0.977
Therefore cutting force= power/cutting velocity = 39/ 0.977 = 39.92 N
Cutting force = 39.92 N

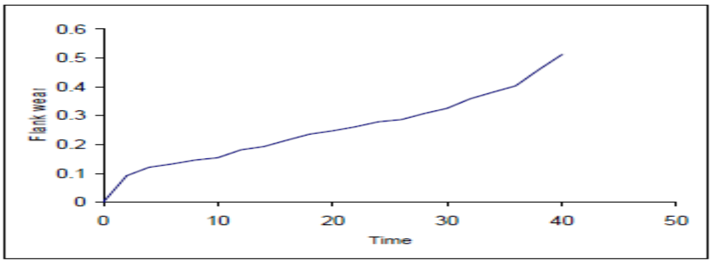

Figure 4..8: Tool wears Vs Time

From graph,
Tool Life = 35 minutes

4.2.9 NINTH RUN:

Cutting Speed = 55.73 m/min
Feed = 0.15 mm/rev
Depth of Cut = 1.0 mm
Temperature = 600 degree

CALCULATION OF CUTTING FORCE:

Average power required = 36.00 Watt
Diameter of the work piece= 0.0415 m
Cutting velocity = πDN/60 = (3.14*0.0415*450)/60 = 0.977
Therefore cutting force= power/cutting velocity = 36.00 /0.977 = 36.87 N
Cutting force =36.87 N

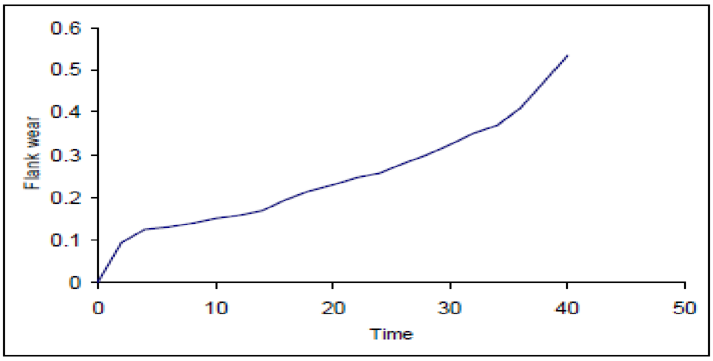

Figure 4.9: Tool wear Vs Time

From graph,
Tool Life = 36 minutes
In this the response is Tool Life. It would be the best if Tool Life is more. So the objective is to maximize the tool life. So we select Larger is Better Signal to Noise ratio.

4.3 ANALYTICAL CALCULATION

4.3.1 CALCULATION FOR CUTTING SPEED AVERAGE SNR

For **cutting speed** = 250 rpm
Average SNR1 for level 1 = (1/3)*(35.59+30.88+30.1) = **32.19**
For **cutting speed** = 350 rpm
Average SNR2 for level 2 = (1/3)*(30.8+30.37+32.04) = **31.07**
For **cutting speed** = 450 rpm
Average SNR3 for level 3 = (1/3)*(31.12+30.6+31.59) = **31.1**
Effect = SNR_1- SNR_3 = 1.09

4.3.2 CALCULATION FOR FEED AVERAGE SNR

For **Feed** = 0.05 mm
Average SNR1 for level 1 = (1/3)*(35.59+30.8+31.12) = **32.5**
For **Feed** = 0.1 mm
Average SNR2 for level 2 = (1/3)*(30.88+30.37+30.6) = 30.62
For **Feed** = 0.15 mm
Average SNR3 for level 3 = (1/3)*(30.1+32.04+31.59) = 31.24
Effect = SNR_1- SNR_3 = **1.26**

4.3.3 CALCULATION FOR DEPTH OF CUT AVERAGE SNR

CALCULATION FOR Temperature AVERAGE SNR

For **temperature** = 600
Average SNR1 for level 1 = (1/3)*(35.59+30.37+31.59) = 32.52
For **temperature** = 400
Average SNR2 for level 2 = (1/3)*(30.88 +32.04+31.12) = 31.34

For temperature = 300
Average SNR3 for level 3 = (1/3)*(30.1+30.8+30.6) = 30.5
Effect = SNR_1- SNR_3 = **2.02**

Table 4.11: AVERAGE SNR TABLE

FACTOR'S SNR	CUTTING SPEED	FEED	DEPTH OF CUT	TEMPERATURE
SNR1	32.19	32.5	32.74	32.52
SNR2	31.07	30.62	31.09	31.34
SNR3	31.1	31.24	30.53	30.5
DELTA	1.12	1.88	2.21	2.02
RANK	4	3	1	2

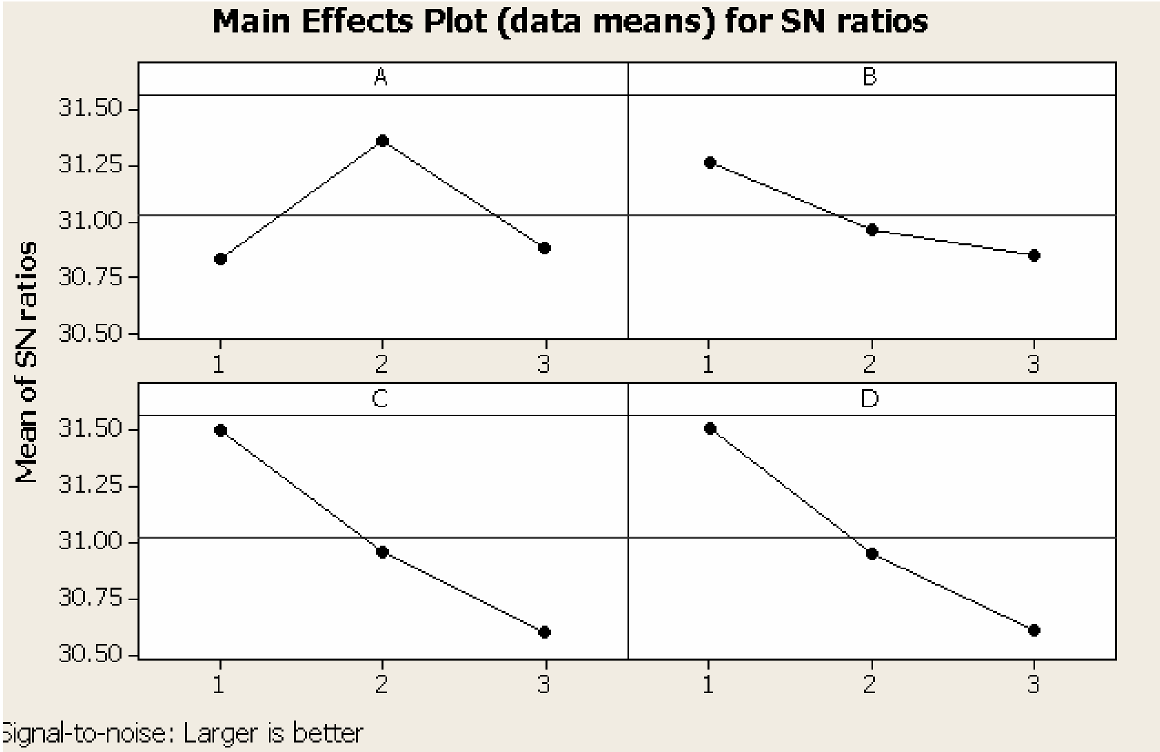

Figure 4.10: Main effect plot of control factors (Tool life)

V. RESULTS

In this project investigation was done with the point of improving the control components of turning activity in hot machining In request to consider the impact of factors and the potential connections between them in a base number of preliminaries, the Taguchi way to deal with trial configuration was embraced. Taguchi plans give a ground-breaking and effective technique for planning items that work reliably and ideally over an assortment of conditions. , the essential objective is to discover factor settings that limit reaction variety, while changing (or keeping) the cycle on track. A cycle planned with this objective will create more steady yield. An item planned with this objective will convey more predictable execution paying little mind to the climate in which it is utilized. From the past investigations it was discovered the force burned-through during turning tasks is principally because of shearing of the material and plastic disfigurement of the metal eliminated. Since both the shear quality and hardness benefits of designing materials decline with temperature, it was along these lines hypothesized that an expansion in work piece temperature would diminish the measure of intensity burned-through for machining and in the long run increment device life .For this test the ideal qualities are discovered to be ***Cutting Speed = 600, Feed = 1, Depth of Cut = 1.5, Temperature = 300***

VI. CONCLUSION

In this project observed by using ATP grade tool for turning operation by Hot Machining and Design of experiments using Taguchi statistical analysis. Find that tool life has increased and power has been decreased. For this experiment the optimum values are found to be Cutting Speed = 450, Feed = 1, Depth of Cut = 1.5, Temperature = 600.

REFERENCES

[1]. Alexandre Mondelin, Valiorgue F, J. Rech, M. Coret, E.Feulvarch. (2013), Modeling of surface unique recrystallization during the all out the route toward turning of the 15-5PH steel, fourteenth CIRP meeting on displaying of machining practices (CIRP CMMO) Vol.8, pp. 311-315.

[2]. Aravindan S, Naveen Sait A, NoorulHaq A, (2008), A machinability assessment of GFRP pipes utilizing credible methods, International Journal of Advanced Manufacturing Technology, Vol. 37, pp. 1069–1081.

[3]. Ashok kumar, Balaji Y, Eswara Prasad N, Gouda, K Tamilmani, (2013), Indegenous improvement and airworthiness accreditation of 15-5PH

precipitation hardenable tempered steel for plane applications, Indian Academy of Sciences, pp. 3- 23.

[4]. Pal D. K., Basu S. K. (1971), Hot machining of austenitic manganese steel by forming, International Journal of Machine Tool Design Research, Vol. 11, pp. 45–61.

[5]. Madhavulu G, Basheer Ahmed, (1994), Hot Machining Process for improved Metal Removal Rates in turning development, Journal of Material Process Technology, Vol. 44, pp. 199-206.

[6]. Hinds B.K, and Almeida S.M.D, (1981),Plasma bend warming for hot machining, International Journal of Machine Tool Design Research, Vol. 21, pp.143– 152.7.Hsiao YF, Tarng YS, Huang WJ. (2010)

[7]. Lopez de Lacalle, L.N., Sanchez, J.A., Lamikiz, A.Celaya.(2004), Plasma helped processing of heatresistant super composites, Journal of Manufacturing Science and Engineering, Vol. 126, pp.274–285.

[8]. Maitya,K.P, Swain P., (2008), A test assessment of hot-machining to anticipate instrument life, journal of materials getting ready advancement Vol. 198, pp. 344– 349.

[9]. Uehara Kunio, Hideo Takeshita.(1986) .Cutting Ceramics with a Technique of Hot Machining.Annal CIRP, Vol. 32, pp. 55–58.

[10]. Ozler,L., Inan,A C. Ozel. (2001), Theoretical and test affirmation of equipment life in hot machining of austenitic manganese steel, International Journal of Machine Tools and Manufacture Vol. 41, pp.163-172

[11]. Ragunath N, Pandey PM.(2007), Improving precision through shrinkage showing by using Taguchi technique specifically laser sintering. Overall Journal of Machine Tools Manufuring Vol. 47, pp. 985–995

[12]. Lei,Y.C. Shin, F.P. Incropera (2001), Experimental assessment of thermo-mechanical characteristics in laser helped machining of silicon nitride ceramics, Journal of Manufacturing Science and Engineering, Vol. 123, pp.639–646.

[13]. Thandra S.K. besides, Choudhury S.K..(2010), Effect of cutting limits on cutting power, surface fulfillment and gadget wear in hot machining, International Journal of. Machining and Machinability of Materials, Vol. 7, pp.260 - 273

[14]. Kitagawa,T., .Maekawa K. (1990), Plasma Hot Machining for new Engineering materials. Wear, Vol. 139, pp.251–26