# ANALYSIS AND OPTIMIZATION OF CUTTING PARAMETERS IN TURNING USING TIC -COATED CARBIDE INSERT ON CHROME -MOLY ALLOY STEEL

**Mr. S. SIVA MOHANA REDDY[1], Dr. T.SURYASEKHARA REDDY[2]**

[1]*P.G. Scholor, Sri Venkateswara Institute of Technology, Anantapuram, AP*
[2]*Principal, Sri Venkateswara Institute of Technology, Anantapuram, AP*

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**Abstract -** *In the present work, the work piece material taken is chrome-moly alloy steel. This is a hard material having hardness 48 HRC. This alloy steel bears high temperature and high pressure and its tensile strength is high. It is very resistive to corrosion and temperature. For these useful properties it is used in power generation industry and petrochemical industry. Also it is used to make pressure vessels. For machining of work piece the insert chosen is Tic coated carbide insert. Three factors speed, feed and depth of cut were taken at three levels low, medium and high. By the L27 orthogonal design twenty seven runs of experiments were performed. For each run of experiment the time of cut was 2 minutes. The output responses measured were surface roughness, power consumption, chip reduction co-efficient and tool wear (flank wear). All the output responses were analyzed by SN ratio, analysis of variance, and response table. The criteria chosen here is smaller the better and the method applied is Cutting tools.*

## 1. INTRODUCTION

Hard machining means machining of parts whose hardness is more than 45HRC but actual hard machining process involves hardness of 58HRC to 68HRC.The work piece materials used in hard machining are hardened alloy steel , tool Steels, case – hardened steels, nitride irons, hard – chrome – coated steels and heat – treated powder metallurgical parts.

### 1.1 ADVANTAGES OF HARD MACHINING

- Complex part contours can be easily machined by this process.
- Component types can be quickly changed over in this process.
- In one set – up, many operations can be completed.
- Metal removal rate is very high.
- The CNC Lathe which is used for soft turning process can be used for this process.
- Investment in machine tool is very low.
- Metal chips produced in the process are environmentally friendly.
- No coolant is required in many cases.
- Tool inventory required is small.

### 1.2 LIMITATIONS OF HARD MACHINING

- The cost of tooling in case of hard machining is higher than grinding.
- For hard turning the length to diameter (L/D) ratio should be small. For unsupported work pieces it should not be more than 4:1 because long thin parts will induce chatter due to high cutting pressure.
- For hard machining to be successful, the machine used must be rigid. The degree of hard turning accuracy is known from degree of machine rigidity. If we want to maximize the machine rigidity than we have to minimize overhangs, tool extensions and to eliminate shims and spacers.

## 2. LITERATURE REVIEW

**Dilbag singh and P. Venkateswara Rao** investigated how surface roughness in bearing steel (AISI 52100) is effected by cutting condition and tool geometry. In this investigation mixed ceramic inserts which are made from Aluminum oxide and Titanium carbonitride(SNGA) which have different nose radius and different effective rake angle are used. In this study they concluded that S.R is affected by feed significantly followed by nose radius and cutting velocity. S.R. is affected very less by effective rake angle but interaction effect of nose radius and effective rake angle is significant. RSM is used to develop mathematical model.

**Tugrul O zel** has investigated how surface roughness and resultant force in hard turning of AISI H13 steel is effected by cutting edge geometry, hardness of work piece, feed and cutting speed. In this investigation four factor two level fractional factorial experiments are used and CERAMICSis applied. Hardness of work piece, geometry of edge, feed and cutting speed are the four factors. In hard turning experiment cutting force, feed force, thurst force and surface roughness were measured. From the study the significant factors on surface roughness are found to be hardness of workpiece, geometry of cutting edge, feed and cutting speed. Lower workpiece hardness and honed edge geometry produce better S.R.

## 3. STUDY AREA METHODOLOGY

### TOOL WEAR AND SURFACE ROUGHNESS-OVERVIEW

### 3.1 Surface Roughness

Due to the increased knowledge and constant improvement of the surface textures gives the present machine age a great advancement. Due to the demand of greater strength and bearing loads smoother and harder surfaces are needed. The surface texture has direct contact with the functioning of machine parts, load carrying capacity, tool life, fatigue life, bearing corrosion and wear qualities.

Failure due to fatigue always occurs at the sharp corners because of stress concentration at that place. Sharp corner is the place where any surface irregularity starts and that part fails earlier. Surface irregularity at non-working surface also matters for failure. Different requirements demand different types of surfaces so measurement of surface texture quantitatively is essential. The imperfections on the surface are in the form of succession of hills and valleys varying both in height and spacing.

Any material being machined by chip removal process cannot be finished perfectly due to some departures from ideal conditions. Due to conditions not being ideal the surface being produced will have some irregularities and these irregularities can be classified into four categories given as follows:-

- First order:- This type of irregularities are arising due to inaccuracies in the machine tool itself for example lack of straightness of guide ways on which tool post is moving. Irregularities produced due to deformation of work under the action of cutting forces and the weight of the material are also included in this category.
- Second order:- This order of irregularities are caused due to vibration of any kind such as chatter marks.
- Third order:- If the machine is perfect and completely free of vibrations still some irregularities are caused by machining due to characteristics of the process. For example feed mark of cutting tool.
- Fourth order:- This type of irregularities are arised due to rupture of the material during the separation of the chip.
- Further these irregularities of four orders can be grouped under two groups. First group includes irregularities of considerable wave-length of the periodic character resulting from mechanical disturbances in the generating set up. These errors are termed as macro-geometrical errors and include irregularities of first and second order. These errors are also referred to as waviness or secondary texture. Second group includes irregularities of small wavelength caused by the direct action of the cutting element on the material or by some other disturbances such as friction, wear or corrosion. Errors in this group are referred to as roughness or waviness.

### (i) Surface Inspection By Comparison methods

In comparative methods the surface texture is assessed by observation of the surface. But these methods are not reliable as they can be misleading if comparison is not made with surfaces produced by same techniques. The various methods available under comparison method are:-

- Torch inspection
- Visual inspection
- Scratch inspection
- Microscopic inspection
- Surface photographs
- Micro-Interferometer
- Wallace surface dynamometer

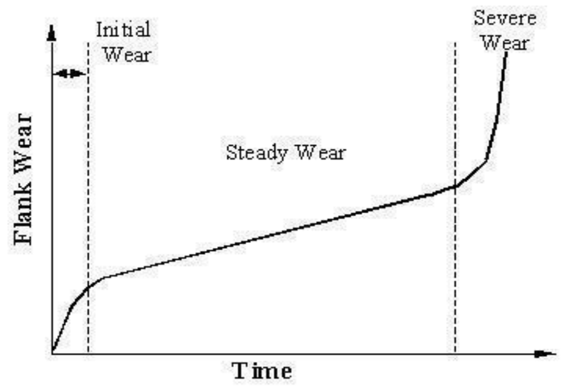



Fig-1: Development of flank wear with respect to time

## 4. EXPERIMENTAL DETAILS

### 4.1. Work piece material:

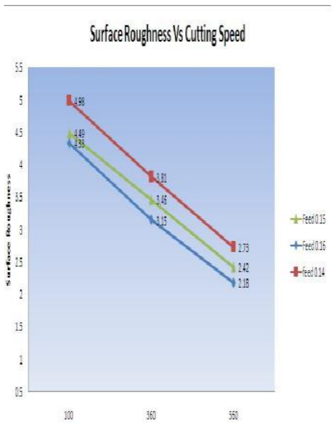
The work piece is chrome-moly alloy which is prepared at cast profile private limited, Kalunga. Its length is 600 mm and diameter is 50 mm. It is heat treated to make its hardness up to 48 HRC the photograph of work piece material and chemical composition of the CR-MO alloy is given below in fig-4.1:

Fig-4.1: Work piece material (Cr-Mo round bar)

### 4.2. Experimental procedure:

The rough work piece of chrome-moly alloy bought from cast profile Ltd, kalunga is first turned to clear the rough skin using uncoated carbide insert. The final diameter of the work piece is made 50 mm. The two ends of the work piece are faced and centering is done using carbide centre drill. The final length of the work piece was made 600 mm.

The main effects for surface roughness that means the graphs of speed vs. mean of S/N ratios of surface roughness, feed vs. mean of S/N ratios of surface roughness, depth of cut vs. mean of S/N ratios of surface roughness for lower is better. As the speed increases the mean of S/N ratios decreases that means good surface finish is obtained with increase in speed. From the graph5.1 (b) it is clear that as the feed increases surface roughness decreases that means increase in feed also gives good surface finish. From the graph it is clear that as the depth of cut increases first surface roughness decreases upto some value and then increases. From three graphs the slope of feed vs. mean of S/N ratio graph is largest, depth of cut vs. mean of S/N ratio graph possesses second largest slope so surface roughness is significantly affected by feed and depth of cut but cutting speed has not significant effect on surface roughness.



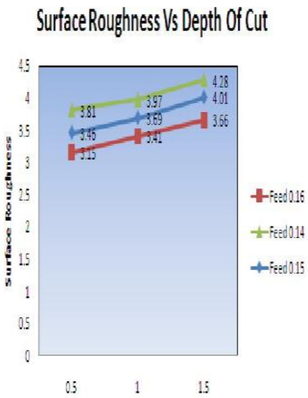




**Fig 5.1:** Surface roughness Vs Cutting speed at Constant Depth of cut = 0.5 mm
**Fig5.2:** Surface roughness Vs Depth of cut at Constant Cutting speed =710 rpm

## 5. RESULTS AND DISCUSSION

Based on experimental results presented and discussed, the following conclusions are drawn on the effect of cutting speed, feed and depth of cut on the performance of Tic coated carbide tool when machining Cr-Mo alloy.

1. The study of Main effect plots of surface roughness indicates that as speed increases mean of SN ratio decreases that means good surface finish is obtained with increase in speed. As the feed increase mean of SN ratio decreases that means good surface finish is obtained with increase in feed. As the depth of cut increases from 0.3mm to 0.5 mm surface roughness decreases but when depth of cut increase from 0.5 mm to 1 mm surface roughness increases.

2. The slope of feed vs. mean of SN ratio is largest, depth of cut vs. mean of SN ratio has the second largest slope so feed and depth of cut affect the surface roughness significantly which is clear from F-statistics of and rank of response table. So feed and depth of cut are dominant factors for surface roughness.

3. As the speed increases SN ratio for power decreases. As the feed and depth of cut increases also SN ratio for power decreases that means less power is consumed for increase of speed, feed and depth of cut.

4. Cutting speed and depth of cut are significant factors in case of power.

5. As the speed increases mean of SN ratio increases that means chip reduction co-efficient becomes more when speed increases. As feed increases from 0.1 to 0.13 chip reduction co-efficient increases and from 0.13 to 0.15 chip reduction co-efficient decreases. As the depth of cut increases chip reduction co-efficient decreases.

6. The depth of cut and speed affect significantly chip reduction co-efficient.

7. n speed increases from 39.275 m/min to 65.982 m/min tool wear increases and from 65.982 m/min to 111.541 m/min tool wear decreases. When feed increases from 0.1 to 0.13 mm/rev tool wear decreases rapidly but from 0.13mm/rev to0.15 mm/rev tool wear increases slowly. When depth of cut increases from 0.3mm to 0.5 mm tool wear increases, from 0.5 mm 1.0 mm it remains constant.

8. Tool wear is affected significantly by cutting speed and depth of cut.

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