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Investigation and Analysis of Process Parameter for Skd11 steel material using Cryo treated cermet in CNC Turning operation

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Abstract - *This work describes the cryogenic treated cermet and untreated cermet used in the machining of the skd11 workpiece. Here various parameters such as speed, feed and depth of cut (doc) are taken as input parameters. Also comparing the surface roughness (RA) value of respective workpiece. Hence this work is useful in determining which cermet is better to obtain surface roughness (RA) value and to improve the quality of surface machined area. Basically these type of operations are being performed using carbide cermet insert in turning operation of skd11 & D2 steel workpiece. The present work explores the effect of cryogenic coolants in machining hardened materials from an industrial perspective view, tool life improvement and environmental effects. The Rockwell hardness test is conducted to show the hardness level of both the tools and their effects. The cryogenic treatment are done in order to remove residual stress and improve wear resistance on steels.*

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I. INTRODUCTION

Metal cutting process forms the basis of the engineering industry and is involved either directly or indirectly in the manufacture on every product of our modern civilization. The cutting tool is one of the important elements in realizing the full potential output of any metal cutting operation. Hence tool such as carbon tool steels, high speed steels and cast alloys to carbides and ceramics has facilitated the application of higher speeds at each stage of development and surface treatments also done to increase the properties of the tool such as

- High resistance to brittle fracture
- Resistance to diffusion
- Resistance to thermal and mechanical shock.

Surface treatments can be categorized into two types

a. Treatments that cover surfaces
b. Treatments that alter surfaces

Treatments that are used for covering the surface are organic coating, inorganic coating, high energy treatments, diffusion treatments, hardening, heavy diffusion treatments and special treatments. In special treatments cryogenic, magnetic and sonic is Included.

II. EXPERIMENTAL PROCEDURE

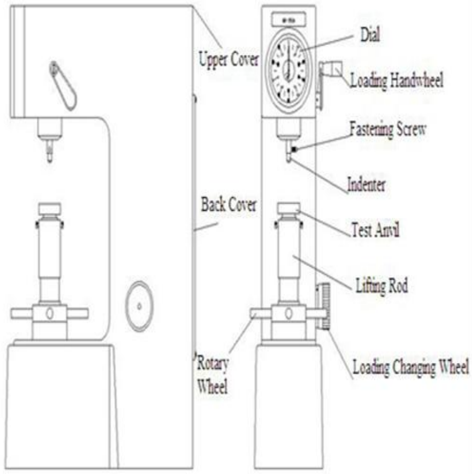
a) MATERIAL SELECTION

Skd 11 is selected as the workpiece and Cryo treated cermet, untreated cermet is selected to be the turning tool. These are selected from the before journals to obtain the better output results. In this experiment Cryo treated and untreated cermet are used to machine Skd 11 workpiece and test are conducted to compare output response.

b) HARDNESS

There are three types of tests used with accuracy by the metals industry; they are the Brinell hardness test, the Rockwell hardness test, and the Vickers hardness test. Since the definitions of metallurgic ultimate strength and hardness are rather similar, it can generally be assumed that a strong metal is also a hard metal.

The way the three of these hardness tests measure a metal's hardness is to determine the metal's resistance to the penetration of a non-deformable ball or cone. The tests determine the depth which such a ball or cone will sink into the metal, under a given load, within a specific period of time. The followings are the most common hardness test methods used in today`s technology:



ROCKWELL HARDNESS TESTER

ROCKWELL HARDNESS TEST

1. Rockwell Hardness systems uses a direct readout machine determining the hardness number based upon the depth of penetration of either a diamond point or a steel ball. Deep penetration indicated a material having a low Rockwell Hardness number.

2. However, a low penetration indicates a material having a high Rockwell Hardness number. The Rockwell Hardness number is based upon the difference in the depth to which a penetrator is driven by a definite light or "minor" load and a definite heavy or "Major" load.

3. The ball penetrators are chucks that are made to hold 1/16" or 1/8" diameter hardened steel balls. Also available are ¼" and ½" ball penetrators for the testing of softer materials.

4. There are two types of anvils that are used on the Rockwell hardness testers.
The flat faceplate models are used for flat specimens. The "V" type anvils hold round specimens firmly.

5. Test blocks or calibration blocks are flat steel or brass blocks, which have been tested and marked with the scale and Rockwell number. They should be used to check the accuracy and calibration of the tester frequently.

Using the "C" Scale;

a. Use a Diamond indenter

b. Major load: 150 Kg, Minor load: 10 Kg

c. Use for CERMET INSERTS

C) MACHINING

The challenge of modern machining industries is mainly focused on the achievement of high quality in terms of surface finish, high production industry, work rate, economy of machining in terms of cost saving and increase the performance of the product with reduced environmental impact. Machining of hardened steel is particularly common in bearing and automotive industries. The new achievement in machine tools technology and use of new cutting tools provide the opportunity to take loads from hardened steel through process such as lathing.

D) TURNING OPERATION

Turning is to remove material from the work piece to produce cylindrical surfaces. The work is turned straight when it is made to rotate about lathe axis and the tools is fed parallel to the lathe axis the Turning reduces a cylindrical surface by removing excess metal from the work piece .

CNC TURNING MACHINE

The CNC turning is a machine tool capable of performing various turning and related operations, on work piece in one set up under CNC system.

These are generally provided with two axis control, Z axis parallel to the spindle and X axis perpendicular to the spindle axis. Turning centres are provided with a slant bed to allow for better view of the machining plane as well as for easy placement of various devices involved in the machine zone. The CNC turning centre is a machine tool capable of performing multiple machining operations on work piece in one setup under CNC system typical machining operation performed on machining centre include turning, milling, drilling, boring, reaming and tapping.

A) MACHINING PARAMETERS

i. Cutting speed

The cutting speed of a cutting tool may be defined as the speed at which the cutting edge passes over the material. Cutting speed ordinarily expressed as meter per minute.

ii.Feed

The feed of a cutting tool is the distance the tool advances into or along the work piece each time the tool point passes a certain position in its travel over the surface.

iii. Depth of cut

The depth of cut is the perpendicular distance measured from the machined surface to the uncut surface of the work piece. In a lathe the depth of cut expressed as follows

Doc= d1-d2 / 2 Where d1=diameter of the work surface before machining.

d2=diameter of the work surface after machining.

III. EXPERIMENTAL WORK

A) PROPERTIES OF METAL

The term property may be defined as the quantity which defines the specific characteristics of metal.

B) MECHANICAL PROPERTIES

The mechanical properties of a metals are those properties which completely defines its behaviour under the external loads or forces. In other words mechanical properties are those properties which are associated with its ability to resist failure as well as behaviour under the action of the external force. These properties include hardness, elasticity, plasticity, ductility, brittleness toughness stiffness, creep etc.

C) EXPERIMENTAL DESIGN

TAGUCHI DESIGN

The Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only. The experimental results are then transformed into a signal – to – noise (S/N) ratio to measure the quality characteristics deviating from the desired values.

Usually, there are three categories of quality characteristics in the analysis of the S/N ratio, i.e., the – lower – better, the – higher – better, and the – nominal – better. The S/N ratio for each level of process parameter is compared based on the S/N analysis. Regardless of the category of the quality characteristic, a greater S/N ratio corresponds to better quality characteristics. Therefore, the optimal level of the process parameters is the level with the greatest S/N ratio Furthermore, a statistically significant with the S/N and ANOVA analyses, the optimal combination of the process parameters can be predicted.

There are 3 Signal-to-Noise ratios of common interest for optimization of Static Problems. The formulae for signal to noise ratio are designed so that an experimenter can always select the largest factor level setting to optimize the quality characteristic of an experiment. Therefore a method of calculating the Signal-To-Noise ratio we had gone for quality characteristic. They are

1. Smaller-The-Better,

2. Larger-The-Better,
3. Nominal is Best.

SMALLER IS BETTER
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 log 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 combination.
LARGER IS BETTER
The signal-to-noise (S/N) ratio is calculated for each factor level combination. The formula for the larger-is-better S/N ratio using base 10 log is: 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.

NOMINAL IS BEST
The signal-to-noise (S/N) ratio is calculated for each factor level combination. The formula for the nominal-is-best I S/N ratio using base 10 log is: S/N = -10*log (s2) Where s = standard deviation.

IV. RESULT AND DISCUSSION

HARDNESS
The term hardness may be defined as the property of a metal by virtue of which it is able to resist abrasion, indentation (or penetration) and scratching by harder bodies. It is measured by the resistance of the metal which it offers to scratch.
Carbide CERMET (TNMG-TT 5100-04) insert

BEFORE HEAT TREATMENT (UNTREATED CERMET)

SL.NO	TRIAL-1&2	AVERAGE HRS
1	72, 73.5	73

TABLE 1

AFTER HEAT TREATMENT
(TREATED CERMET)
TABLE 2

SL.NO	TRIAL-1&2	AVERAGE HRS
1	76.5, 77	77

DESIGN OF EXPERIMENT

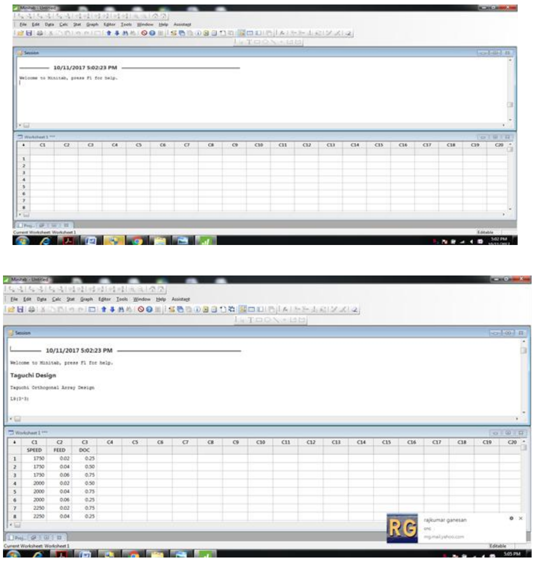
Process parameters and their levels responses for all noise factors for the given factor level combination

TABLE 3

Levels	**Process parameters**		
	Spindle Speed (*N*) (rpm)	**Feed (*f*) (mm/rev)**	**Depth of cut**
1	1750	0.02	0.25
2	2000	0.04	0.50
3	2250	0.06	0.75

MINITAB-17 SOFTWARE

By using Minitab-17 software have optimized the Turning parameters selected through DOE principle OF TAGUCHI sheet as shown in fig below:



MINITAB 17 Work sheet.

The Turning operation on various parameters such as spindle speed, feed, and depth of cut is done on skd11 workpiece based on the table value obtained through L9 orthogonal array through Taguchi design on minitab-17 software.

Process parameters and variables

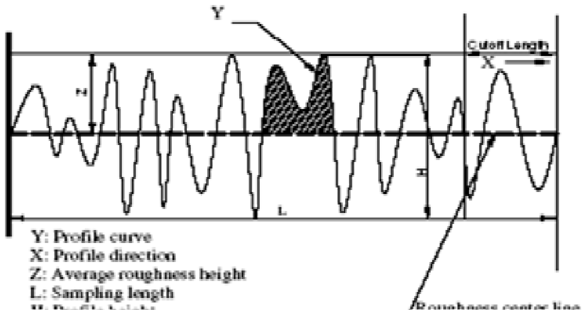
S.NO	**Spindle Speed (*N*) (rpm)**	**Feed (*f*) (mm/rev)**	**Depth of cut**
1	1750	0.02	0.25
2	1750	0.04	0.50
3	1750	0.06	0.75
4	2000	0.02	0.50
5	2000	0.04	0.75
6	2000	0.06	0.25
7	2250	0.02	0.75
8	2250	0.04	0.25
9	2250	0.06	0.50

CNC MACHINING

- Machine Tool: LMW smart urn CNC lathe.
- Work specimen material: SKD-11.
- Size of material: Φ32mm X 60 mm.
- Tool material: Carbide - TNMG -TT-5100-04 inserts.
- Environment: Without Coolant used.

SURFACE ROUGHNESS

The surface parameter used to evaluate surface roughness in this study is the roughness average (Ra). The roughness average is the area between the roughness profile and its central line, or the integral of the absolute value of the roughness profile height over the evaluation length. There are a great number of factors influencing the surface roughness and Figure shows all influential factors on machined surface roughness. Roughness consists of the finer irregularities of the surface texture, usually including those irregularities that result from the inherent action of the production process. The roughness component of surface is generally quantified by the parameter roughness average (Ra). Surface roughness is an effective parameter representing the quality of machined surface. Ra is the area between the roughness profile and its mean line, or the integral of the absolute profile height over the evaluation length as shown in Figure



Surface roughness profile

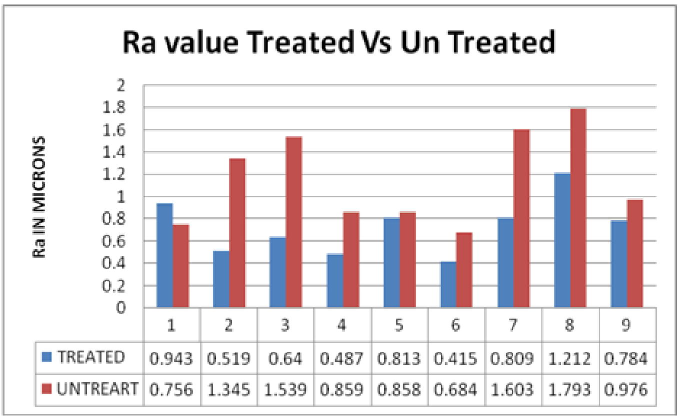
Therefore, the Ra is specified by this equation: From this equation, Ra is the arithmetic average deviation from the mean line, L is the sampling length, and Y is the ordinate of the profile curve.

EXPERIMENTAL DATA

S.NO	Design	**Spindle Speed (*N*) (rpm)**	**Feed (*f*) (mm/rev)**	**Depth of cut**	RA TREATED	RA UN TREATED
1	$A_1B_1C_1$	1750	0.02	0.25	0.943	0.756
2	$A_1B_2C_2$	1750	0.04	0.50	0.519	1.345
3	$A_1B_3C_3$	1750	0.06	0.75	0.640	1.539
4	$A_2B_1C_2$	2000	0.02	0.50	0.487	0.859
5	$A_2B_2C_3$	2000	0.04	0.75	0.813	0.858
6	$A_2B_3C_1$	2000	0.06	0.25	0.415	0.684
7	$A_3B_1C_3$	2250	0.02	0.75	0.809	1.603
8	$A_3B_2C_1$	2250	0.04	0.25	1.212	1.703
9	$A_3B_3C_2$	2250	0.06	0.50	0.784	0.976

COMPARISON OF SURFACE ROUGHNESS

The surface roughness which is taken with the help of surface roughness tester is listed above on the table is shown using the graph shown below



V. CONCLUSION

The various Input parameters were selected for CNC turning of SKD-11 steel. The work piece had turned with various parameters like speed, feed DOC in order to achieve the high degree surface finish as well as minimum cycle time and maximum MRR .The surface roughness test is also conducted and the following values are mentioned below:

TREATED CERMET	UNTREATED CERMET
0.943	0.756
0.519	1.345
0.640	1.539
0.487	0.859
0.813	0.858
0.415	0.684
0.809	1.603
1.212	1.703
0.784	0.976

RA	**TREATED CERMET**	**UNTREATED CERMET**
AVERAGE	0.736	1.052

Hence I conclude that surface roughness is better while machining through Cryo treated cermet and hardness is better in Cryo treated cermet compared with the normal cermet tool.

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