ISSN: 2454-7875
VOLUME 3, ISSUE 6, Jun.-2017

COMPARATIVE STUDY OF WEAR BEHAVIOR OF M35 TOOL STEEL ON TREATED AND UNTREATED CUTTING TOOL ON LATHE MACHINE

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ABSTRACT:

The aim of this study is to reveal the enhancement of wear resistance of AISI M35 tool steel by cryogenic treatment and Heat treatment by observing their tool life in terms of cutting length and surface roughness value obtained. Cryogenic treatment is often referred as cryo treatment, is an add-on process to the conventional heat treatment. In the experimentation process we have made two single point cutting which have undergone through heat treadment and cryogenic treatement. Those two tools we have fitted on standard all gear lathe machine. On Lathe machine we have conducted experimentation process for tool life keeping Speed (N), Feed (F), and Depth of Cut (D) as a input process parameters and tool life in terms of Cutting length and roughness value as a output parameter. Along with various angles and faces of tool the tool nose radios plays a very important role in producing good surface finish on component. Hence effect of this radius also has studied in this experimentation. Considering the length of paper we have not included microstructural details of material gone under processes.

KEYWORDS: Heat treatment, cryogenic , cutting parameter , tool life, cutting length, tool nose radius, Roughness value (Ra).

1 INTRODUCTION:

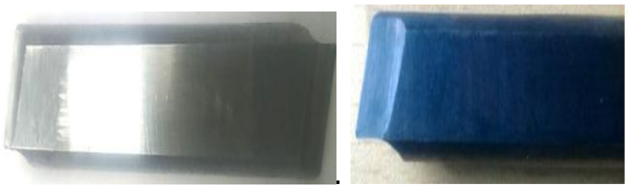
The commonly used cutting tool material in conventional machine tools is high speed steel. As the technology has been more rapidly advancing, cutting tool materials such as cemented carbides and ceramics are needed to machine many difficult to machine materials at higher cutting speeds, and metal removal rates (MRR) with performance reliability. [1] with increasing demand now a days for MRR cutting tool should be strong enough to work efficiently under higher cutting parameters. To make cutting tool stronger it has to undergo a hardening and cryogenic process.[6] Mohan Lal et al. [2] studied the improvement in wear resistance, and the significance of treatment parameters, in different tool and die materials. It has been found that cryogenic treatment imparts nearly 110% improvement in cutting tool life. Cohen et al. [3] proved that the power consumption of cryogenically treated (HSS) tools is less, when compared to the untreated (HSS) tools. Cryogenic treatment of tool steels is a proven the technology to increase the wear resistance, and extend intervals between component replacements for blades, machining mills, etc., and hence improves surface quality of the different machined parts. Correct mechanical configuration, Combining optimized lubrication, and cryogenic treatment of wearing parts results in the maximum performance of lubricated components, and can significantly extend the component life. Cryo-treatment is a supplementary process to conventional heat treatment, that involves deep freezing of materials at cryogenic temperatures (-190 °C) to enhance the mechanical and physical properties. The execution of CT on cutting tool materials increases wear resistance, hardness, dimensional stability, but at the same time, reduces tool consumption and down time for the machine tool set up, thus leading to cost reductions. The dry cryogenic process is precision controlled and the materials to be treated are not directly exposed to any cryogenic liquids. Overall, all the treated materials retain their size and shape. Cryogenically treated materials with some occasional heat treatment generally improve hardness, toughness, stability, corrosion resistance and reduced friction[4] Metal cutting process is one of the complex process which has numerous factors contributing towards the quality of the finished product. CNC turning is one among the metal cutting process in which quality of the finished product depends mainly upon the machining parameters such as feed, speed, depth of cut, type of coolant used, types of inserts used etc. Similarly the work piece material plays an important role in metal cutting process. While machining, optimized machining parameters results in good surface finish, low tool wear, etc.[8]

ISSN: 2454-7875
VOLUME 3, ISSUE 6, Jun.-2017

2. SYSTEM DEVELOPMENT:

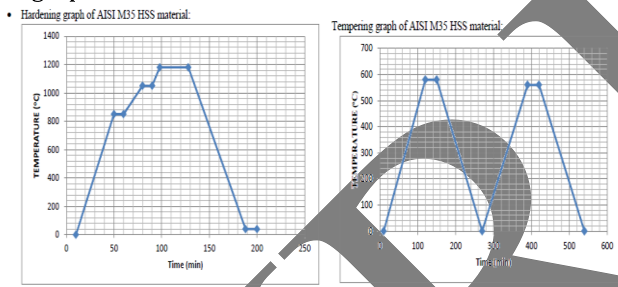
Heat treatment refers to heating and cooling operation of a metal or an alloy in the solid state for the purpose of obtaining desired properties. It includes physical, mechanical or chemical. It is also used to modify internal structure of the material. To increase hardness, wear and abrasion resistance. Improve mechanical properties such as ductility, strength, toughness etc.

In this experiments first we prepared two single point cutting tool of a M35 HSS material and given with standard angles to the tool. And just in order to study the effect of nose radius on surface generation we did not give this radius to the tool.



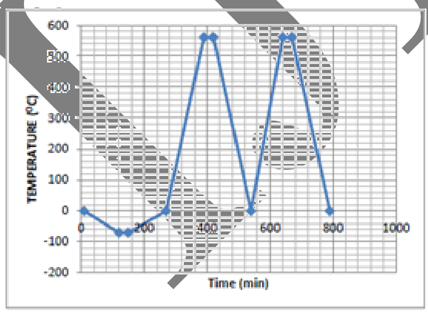
Photograph: 01 heat treated and cryogenically treated tool

After that we carried out vacuum heat treatment process on both the tool. Cycle used for this is shown in the graph 01



Graph 01: heat treatment

Then we have carried out a shallow cryogenic treatment on second tool. Cycle used for this is shown in the graph 02



Graph 02: cryogenic treatment

Then with these two tools we have done experimentation on Lathe machine for tool life keeping Speed (N), Feed (F), and Depth of Cut (D) as a process parameters and tool life in terms of Cutting length and roughness value as a output parameter. The main purpose of this experimentation is to reveal that what is the effect on tool life of these two tools by calculating total cutting length cut before tool breaks. Also we have added the effect of tool nose radius on surface generation by getting Ra(roughnes) value from the component simultaneously. Also we have kept depth of cut as continuously increasing parameters in order to consider the time constraints available.

3. EXPERIMENTAL PROCEDURE:

EXPERIMENTAL DETAILS AND SPECIFICATIONS:

i. Machine tool : All geared Lathe
ii. Machine specifications: max speed:650rpm, min speed: 44 rpm, swing diameter:200 mm, length: 4 feet 6 inch, motor capacity:1.5 H.P
iii. Work material : Mild Steel
iv. Cutting tool : single point cutting tool of M35 HSS tool steel (C-0.89%, Si-0.34%, Mn-0.27%, P-0.021%, Cr-3.81%, Mo-5.18%, V-1.86%,W-6.02%, Co-4.69%, Ni-0.37%.)
v. Cutting conditions : Wet cooling environment
vi. Surface roughness measuring instrument: Mitutoyo SJ-201P
vii. Traverse Speed : 1mm/sec
viii. Measurement : Metric

- **EXPERIMENTAL SETUP FOR MEASURING MACHINE:**

- **INPUT PARAMETERS**:

Speed, Feed, Depth of Cut, Cutting length and Coolant supply. Out of above input parameters speed, feed, coolant and cutting length we kept constant by varying depth of cut for all the sets and for both tools i.e. Heat treated tool and Cryogenically treated tool as shown in the table below.

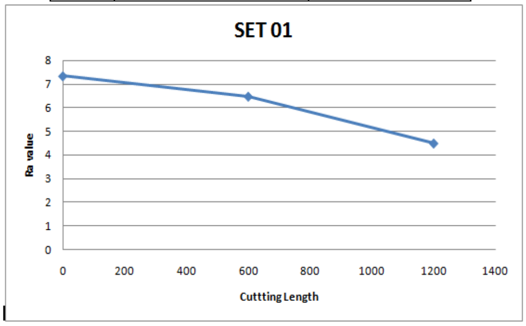
Set No.	Speed	Feed(mm/rev)	Cutting length(mm)	Depth of cut (mm)
1	575	0.5	1200	0.5
2	575	0.5	1200	1
3	575	0.5	1200	2
4	575	0..5	1200	3
5	575	0.5	1200	4

4. RESULT AND DISCUSSION:

RESULTS FOR HARDENED TOOL:

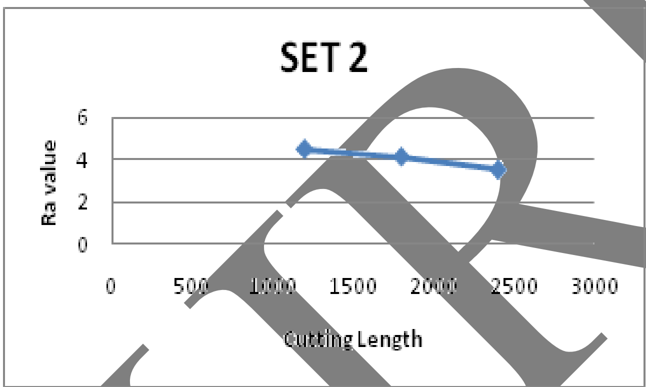
Set 1: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=0.5 mm.

Sr no	Cutting Length(mm)	Ra Value(micron)
1.	0	7.34
2.	600	6.48
3.	1200	4.5



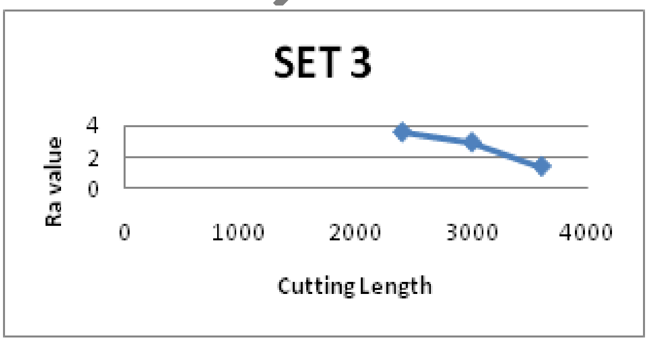
Set 2: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=1 mm

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	1200	4.5
2.	1800	4.15
3.	2400	3.54



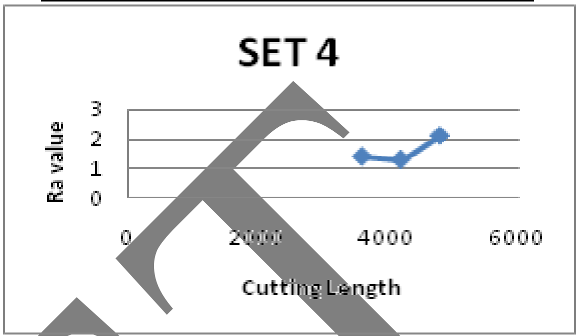
Set 3: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=2 mm

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	2400	3.54
2.	3000	2.9
3.	3600	1.4



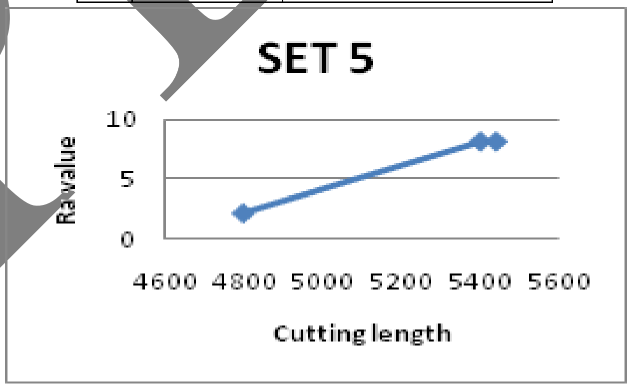
SET 4: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=3mm.

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	3600	1.4
2.	4200	1.3
3.	4800	2.1



SET 5: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=4mm.

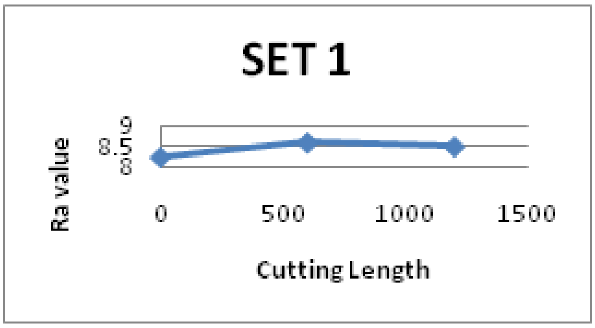
Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	4800	2.10
2.	5400	8.10
3.	5440	8.10 (Tool point break)



- **WITH HARDENING AND CRYOGENIC TOOL:**

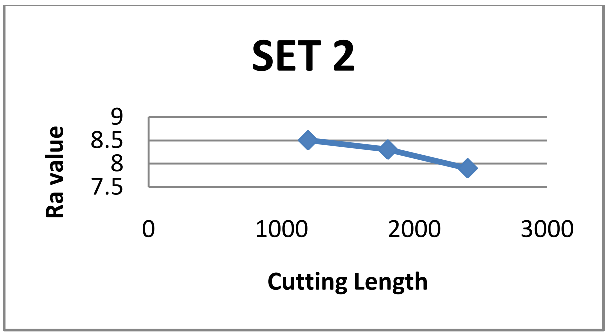
SET 1: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=0.5 mm

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	0	8.24
2.	600	8.6
3.	1200	8.5



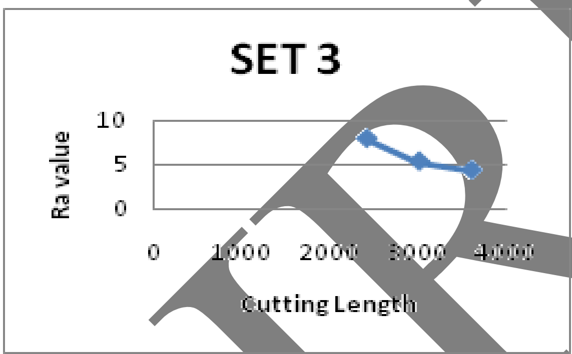
SET 2 : SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=1 mm

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	1200	8.5
2.	1800	8.3
3.	2400	7.90



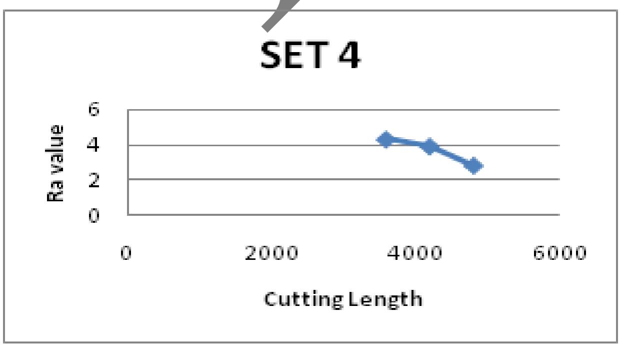
SET 3: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=2 mm.

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	2400	7.90
2.	3000	5.3
3.	3600	4.3



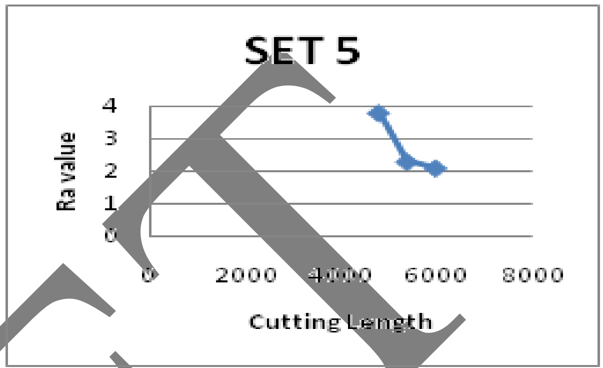
SET 4: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=3mm.

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	3600	4.3
2.	4200	3.9
3.	4800	2.8



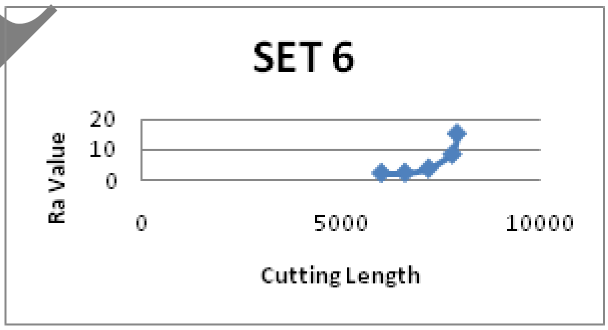
SET 5: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=4mm.

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	4800	3.80
2.	5400	2.30
3.	6000	2.10



SET 6: SPEED =575 rpm FEED=0.5 mm/rev DEPTH OF CUT=4mm.

Sr no	Cutting Length(mm)	Ra (Surface Roughness Value)(micron)
1.	6000	2.10
2.	6600	2.2
3.	7200	3.6
4.	7800	8.3
5.	7920	15.10 (Tool point break)



5. DISCUSSION:

After the experiment we found out variation of roughness value with cutting length. We have plotted cutting length on x axis and roughness value on y axis. We got relation between both as effect of presence and absence of nose radius on cutting tool used for cutting. We also found the difference in cutting length sustained under condition by both the tool as a effect of process carried out.

- **ON HARDENING TREATED TOOL**:

i. From set-1 to set-4 (Till cutting lenth 4200mm) we can observe initially Ra value is high because we have not given nose radius to the tool. But as we kept on cutting material because of gradual wear nose radius to the tool tend to achieve and Ra value becomes smaller.

ii. But in set-4 (after cutting lenth of 4200mm) we can observe Ra value is again increasing that is because of nose radius of tool goes beyond required value and in set-5 tool becomes blunt and is not suitable for further cutting.

iii. Total cutting length before tool gets blunt= **5400** mm

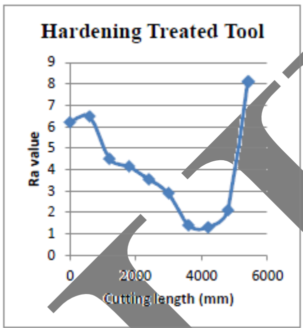
- **ON HARDENING AND CRYOGENICALLY TREATED TOOL**:

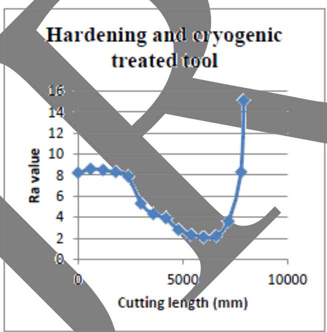
i. From set-1 to set-5 (till cutting length 6000) we can observe initially Ra value is high because we have not given nose radius to the tool. But as we kept on cutting material because of gradual wear nose radius to the tool tend to achieve and Ra value becomes smaller

ii. But in set-6 (After cutting length of 6000mm) we can observe Ra value is again increasing that is because of nose radius of tool goes beyond required value and in set-6 tool becomes blunt and is not suitable for further cutting.

iii. Total cutting length before tool gets blunt= **7800** mm

Above result shows that cryogenically treated tool has better tool life than just conventionally hardened tool.





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