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ANALYSIS OF TOOL LIFE AND SURFACE ROUGHNESS IN TURNING OF EN1AL MATERIAL BY USING CRYOGENIC TREATED TOOL

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ABSTRACT

The need to develop more and more resistant tool materials able to cut increasingly resistance work piece materials and the demand of the technological development for higher productivity and lower costs have caused many materials cemented carbide, cermets, ceramics and ultra hard material to emerge. Studies on cryogenically treated high speed steel tool show micro structural changes in the material that can influence tool lives and productivity significantly. However, the real mechanisms which guarantee better tool performance are still dubious. This implies in the need of further investigation in order to control the technique more scientifically. The main objective of this research is to focus on increase in tool life and reduce in surface roughness after cryogenic treatment of HSS Tool. During turning operations tool life depends upon many factors but we have concentrated 3 major factors which is Cutting Speed, Feed rate and Depth of cut. In this project we have compared Cryogenic Treated HSS tool bit life with Untreated HSS tool life in Industrial case Study.

Keywords: - *Surface Roughness, Tool Life, Productivity, Cryogenic Treatment, HSS Tool.*

I. INTRODUCTION

As we know the commonly used cutting tool material in conventional machine tools is HSS. As the technology is rapidly advancing newer cutting tool materials such as Cemented Carbides, Cermets and Ceramics are needed to machine many hard materials at higher cutting speed and material removal rate with performance reliability. Further there are some materials which are soft in nature can be machined with the help of HSS tool. But the main problem with HSS tool is reduced tool life due to its structural geometry. Also medium scale mass production based company cannot afford the machine (CNC) on which carbide inserts are used for machining. They depend totally on HSS tool for machining of soft materials. But the main problem with HSS tool is minimum tool life which directly affects the overall productivity of company.

Desired target of job with maximum profit and to have all cost within the limit (manufacturing cost, cutting cost) and to enhance the productivity there must be some mechanism required to HSS tool. This mechanism now-a-days available in terms of cryogenics treatment. Deep Cryogenic treatment is the methodology of “ultra low temperature” processing of materials to enhance their material properties. The process involves reducing and rising the temperature. Thermal control is achieved by continuously monitoring inputs and regulating the flow of liquid Nitrogen into chamber and alerting the heat. Cryogenic treatment on HSS tool bit results in conversion of retained Austenite into Marten site. This results in increase in hardness of HSS tool bit due to increase in density of dislocation and gaps [1].

In recent decades, interest in low temperature affects has been demonstrated particularly during heat treating cycles of tool steels. Some literature data indicates that lives of tools and other steel components may increase significantly after being submitted to sub zero temperature. The reports of 92-817% increases in tool lives after they have being treated at -196^{0}C are found [2]. Unlike coatings that are only a superficial treatment, the cryogenic treatment is applied to whole volume of material reaching the core of the tool. This guarantees maintenance of their properties even after regrinding or resharpening [3].

The research has been shown that the cryogenic treatment increases product life and in most cases provides additional qualities to the product such as stress relieving, toughness, etc [1].

In this paper, we are dealing with two factors that majorly affect the productivity and quality and that factors are: Tool Life and Surface Roughness. In order to evaluate different results and productivity while machining of EN1AL materials we have undergone through different tests, such as Hardness Test, Rapid Facing and Shop Floor Test.

II. LITERATURE REVIEW

To understand the effects of cryogenic processing it is essential that one be acquainted with the heat treating of material. The primary reason for the heat treating steel is to improve its wear resistance through hardening. Gears, bearing and tooling for example are hardened because they need excellent wear resistance for extended reliability and performance The steps in Heat-treating are frequently explained in simplistic manner but it takes significant skill and experience to execute heat treatment successfully. Steel will normally be raised in temperature to the austenizing temperature, usually 1600^{0}F or higher. Austenite is a soft phase of steel hence it is very east to wear structure down with repeated use, therefore need of heat treating. After predetermined period of time at the elevated temperature, the material will be quenched in a bath that may be oil, water, brine or polymeric compound. The rapid cooling (quenching) of steel in the quenching medium will cause the item in the microstructure rearrange in the atomic structure that is called Matensite

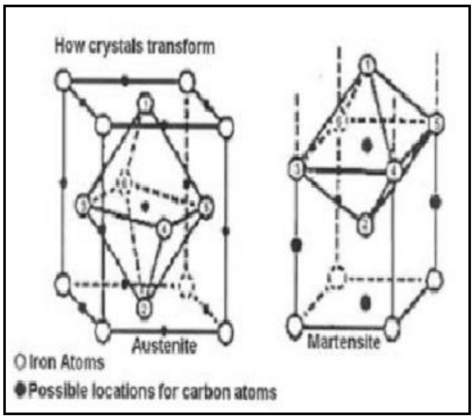
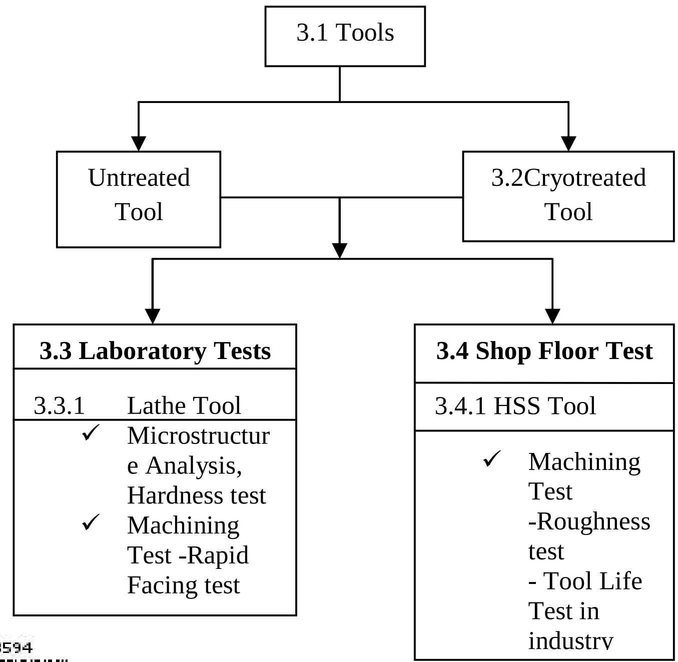


Fig.1 shows the representation of atomic structure of austenite and martensite phase.

This basic phenomenon causes increase in Hardness due to such phase transformation. Objective of Study of this study is to evaluate changes in surface finish due to machining with cryotreated tool and to evaluate increase in tool life in terms no. of jobs Machined.

III. METHODOLOGY OF RESEARCH



WORK PIECE MATERIAL

EN1AL is basically a soft material. This material is used for the Back break piston which is sub part of Tendum Master Cylinder. This cylinder is important part in the break assembly of Automobile. Hence we have selected for analysis this material.

MACHINE

Basically this machine Special purpose Machine which is automatic in nature .Semi automatic Lathe machine was used to test cut the soft Material. It has maximum 10 Kw spindle power and maximal Machining diameter of 20 mm with mm 10 distances between the centres, a maximum spindle speed of 750 rpm.

MEASURING EQUIPMENT

Mititoyo Surface Roughness tester is used to measure surface roughness of work piece machine during experiment the surface roughness was measured at 4 locations around work piece circumference. The value of the surface roughness is the average of 4 points taken for each measurement.

DESIGN OF EXPERIMENT

The design of experiment is an effective tool for maximizing amount of information gained from study while minimizing the amount of data collected. This experiment is carried out at industrial level in standard condition. In this experiment after setting of cutting condition on the respective machine the usual machining is done, the coolant is supplied at regular quantity. The component is machined and regular interval the components are taken out for measurement purpose at frequent interval of time. This procedure is done for analyzing the surface Roughness. After this in order to investigate tool life the surface finish is checked at regular interval and if surface finish is beyond limit as decided from standard roughness value that is considered as end of tool life. And by careful observation on machine after how many number component the tool is blunt and in this way tool life is investigated in terms of no. of component machined.

TOOL MATERIAL

The tool material used is High Speed Steel. The tool is supplied by ROHIT manufacturer of tool. The size of tool is 3/8”*3/8”.This tool is excellent for machining most steel and specially EN1AL material series. The three input cutting parameters are cutting speed, Feed rate and Depth of cut were selected according to job specification.

Speed	Feed rate	Depth of cut
750	0.027-0.035	0.2

With the combination of these three parameters reading for surface roughness and tool life were are observed.

IV. RESULTS AND DISCUSSION

Basically this test is done to investigate the relation between the Cryogenic treatment and Surface Roughness. This test is done on the Lathe Machine with the help of Miranda Make HSS tool bit. For this we have taken 54 test work pieces. Out of which 27 work pieces are for untreated tool bit and 27 is for Cryotreated HSS tool bit. The cutting condition of the test is taken from Taguchi Analysis. The array used is L9 Array.

SURFACE ROUGHNESS RESULTS FROM INDUSTRIES

The practical result from industries in case of surface roughness is as follows, these results will show the practical difference in case of untreated tool and cryotreated tool.

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Table 1.1 Results of Surface Roughness from industries

Untreated tool roughness value		Cryotreated roughness value	
Job.1	1.113.	Job.1	1.108
	1.122		1.090
	1.129		1.079
Job.2	1.800	Job.2	1.583
	1.801		1.609
	1.812		1.621
Job.3	1.865	Job.3	1.700
	1.868		1.720
	1.876		1.742

As we have survey in industry the basic surface Roughness Value or we can say Average roughness value is 1.5. From above result from industry it is observed that initially this roughness value is maintained properly. But, after some time this roughness value increases greatly from desired value of Roughness Value. But, in case of cryotreated tool this result of desired value is maintained more time. This result of roughness value is not increases with respect to time, but it maintained the desired roughness value. So, we can say that roughness value for the cryotreated tool is less than that of untreated tool.

CASE STUDY IN PRAMEYA INDUSTRIES FOR TOOL LIFE

The test above mentioned are basically related to Surface Roughness. But one of the major factor affects the Production cost and hence Productivity are “Tool Life”. For calculating the actual tool life we have undergone the shop floor test. Basically this test as done in the Industries. The two companies are Prameya Industries and Suyog Industries.

V. TOOL LIFE TEST FOR TURNING OPERATION

For this particular divided tool life into three types for Roughening operation, super finishing operation & Special purpose operations. The first operation is turning operation. The result of turning operation is as follows:

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DESCRIPTION OF TEST

The operation is carried out on the fixed cutting conditions of-

Speed= 750 rpm
Feed=0.025-0.035 mm/rev
Depth of cut = 0.2 mm

The simple HSS tool and cryogenic tool are mounted at a same time on two machines. The tool life is calculated in the form of number of pieces cut till the tool damaged or roughness of component deflects. The results of our tests are shown below. Tool Life from Industries

Table 10.2 Results of Tool Life from industries

Sl.No	Speed	Feed rate	Depth of cut	No. of pieces machined
Untreated tool	750	0.025-0.035	0.2	2500
Cryotreated tool	750	0.025-0.035	0.2	5500

Above result show that cryogenic treatment on HSS tool for turning operation gives better result in terms of number of work pieces produced for same tool. And this result is given along with maintaining tool life at maximum level. About 3000 components are produced more than Untreated HSS tool. Now in next chapter we will discuss how this tool life along with maintaining surface finishes improves the productivity of the company.

VI. CONCLUSION

1) From result of hardness test it is seen that the hardness slightly increases. It affects on surface finish of the component.
2) From result of roughness test we can conclude that due to higher thrust force at the periphery of the component, the surface roughness is greater as compared to centre roughness of the component in both cases. But, surface finish obtained at outer periphery by

3) Cryotreated tool is slightly higher than HSS tool.

4) From shop floor test we can easily conclude that the tool life is increase by 220% which is more input to increase the productivity.

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