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Increasing the Life of AISI/SAE 1020 HSS Tools Using Cryogenic Treatment

Karthikeyan S[1], Prasannakumar S[2], Deepak R[3], Kalyanasundaram R[4], Shameer D[5]

[1.] M.E(Thermal), (PhD)¯, Assistant Professor, Agni College of Technology, Chennai, Tamilnadu, India.
[2.]M.E(Mechatronics), Assistant Professor, Agni College of Technology, Chennai, Tamilnadu, India.
[3]. M.E(Engineering Design), Assistant Professor, Agni College of Technology.
[4]. M.E(Manufacturing Engineering), (PhD),Assistant Professor, Agni College of Technology.
[5.]M.E(Manufacturing Engineering), Assistant Professor,Agni College of Technology.

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Abstract

In small scale industries, Single-point HSS cutting tools are frequently used in machining operations to comply in lathes. The machines work monotonously for a long time; soon, the deformation of the tool occurs. The continuous contact between the static tool and the rotating job creates heat due to frictional rubbing between them. Therefore, the tool wear increases, which corollary in the inferior surface finish of the job. The bigger the rake point, the lower are the cutting powers and power better is the surface completion. The angle chosen is, therefore, a Comprises efficient cutting and tool strength. To avoid such problems, the tool's hardness is necessary to increase. The main objective is to measure the hardness, flank wear, surface roughness, and microstructural changes for both cryogenic treated and untreated single point cutting HSS tools.

Keywords; *Single point HSS tools, Rake angle, Flank wear, Hardness, Cryogenic treatment, SEM*

I. INTRODUCTION

A single point cutting tool is widely used for machining operations. These tools are utilized in various machines, which gives the last workpiece precision and an alternate pace of surface completion. At the point when these tools are utilized in CNC machines, the accuracy of cut and surface completion is nearly accurate. In any case, when single point cutting tools are utilized in ordinary machine machines, there is no exact and surface completion menace abs. Yet, since CNC machines cost more than typical machines, their customary machine is utilized uniquely in little scale ventures where cost is a factor. Turning activity is the most essential activity that is utilized to decrease the measurement of the workpiece fixed on the pivoting hub, while these tools are stationary on the tool mounting. At the point when a single point cutting tool is utilized in a machine, the single point cutting tool faces different issues. Three zones have been made in the all-out framework. The essential misshaping zone where plastic twisting happens. The consequence of the optional twisting area among the chip and tool interface is auxiliary plastic distortion due to grating where the chip and the tool intersect. Tertiary twisting region among tool and workpiece because of friction rubbing.

The heat generated due to friction in the rub is scattered between the three areas raised by a secondary field that is chips and makes the workpiece ductile resulting in a slight reduction in cutting power, but this heat distortion of the single surface cutting Also influences point cutting tool. Metal cutting procedures can be done by using metal cutting machines, it may also called as “Machine tools” using different types of “cutting

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tools." One major impediment of a metal cutting or machining process is the loss of material in the form of chips. Many machines can perform different operations like a boring machine to make a hole, grinding machine to sharpen the tool, milling machine to make slot, gears, but the essential machine tool is the lathe, which performs many processes.

II. LITERATURE REVIEW

The Characteristics of High-speed steel is relatively good due to its composition, especially 10% cobalt. After cryogenic Process, the characteristics of the treated equipment was pointedly increased. After the cryogenic treatment the HSS is more polished, and the microparticles are evenly spread. The nose radius and weight loss are comparatively lower than untreated tool, and also lower value of roughness in the surface of the tool machined with CT HSS tool represent the positive scope of cryogenic treatment on the tool and die materials. This treatment can also decrease the austenite property but it cannot change the tool into martensite completely.

From scanning electron microscope investigation, it is apparent that modification of carbides is more in the case of cryogenically treated HSS compared to untreated tools. the experimental results indicate that the rake angle impacts the cutting powers, power and surface completion. The bigger the rake point, the lower are the cutting powers and power, and better is the surface completion. Huge rake, in any case, diminishes the cutting edge between the rake and chief flank faces, and less metal is accessible to help the device and direct the warmth created because of plastic misshaping and contact.

"Cryo processing" or "Cryo treatment" is unlike traditional "cold treatment" as the previous is carried out at liquid nitrogen temperatures (−196.15°C) and the Ensue is carried out at dry ice temperature (−80.15°C). Cryo processing is an economical single-time lasting behaviour influencing the whole cutting tool surface, in contrast to coatings; along these lines, comparative result can be normal after individual regrinding of instruments. The three major noteworthy strictures of cryo processing recognised as mainly disturbing the wear resistance tool life are soaking temperature, soaking period, and cooling rate. Though, these behaviour limits need to be enhanced concerning tool and type of Machining procedure.

Untendered tool materials have surface cracks, which are not helpful to the lifespan of cutting tools. The wear resistance capability to cut tool can be increased by including cryo processing in the following order: austenitizing, Quenching, cryo processing, and tempering. The development in wear resistance and hardness by cryo processing is ascribed to the joined impact of the transformation of held austenite to martensite and precipitation of η-carbides in the case of tool steels. This enhanced wear resistance in carbide cutting tools and also increased the η phase particles and bonding strength.

Deep cryogenic treatment can improve the distribution of carbide in M2 HSS, and it can make carbide precipitation more dispersive. The austenite is almost fully transformed after quenching and tempering for three times. The deep cryogenic treatment has no significant effect on the residual austenite. QPQ treatment can effectively enhance the surface hardness of HSS cutting tools. The M2 HSS belongs to fine-grained steel, the grain diameter of which is among 4 to 8 micro/m, and samples in this experiment were tempered for three times, so it is not easy to observe the grain boundaries and change in grain size. But specimens with cryogenic treatment are conducive to the infiltration of nitrogen atoms, so it is possible to conclude that cryogenic treatment could cause grain refinement. The cutting life of the M2 HSS drill can be increased dramatically by cryogenic and QPQ compound treatment.

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3. PROPOSED SYSTEM

The test work in the workshop was completed. Diversion activity was performed on a working example using cryogenically treated and untreated HSS devices. Examples of work of cutting tools, hardness and flank wear surface roughness were estimated. The micrographs of UT and CT HSS evaluation were found in the same way. Both cutting tool blanks (UT and CT HSS) are easily accessible, with these lines, instrument blanks, typical, T42-S-400 (UT) and T42-S-500 (CT), made by Miranda Tools Limited. Are.Were acquired from the market. Evaluation tools were set up according to ideal equipment geometry. The ideal side rake points and nose range were cut from the Small-Scale Industry. Brief test conditions, machine apparatuses, and hardware particulars are given in Table 1. This investigation will additionally be reached out to upgrade these parameters by applying some reasonable Design of Experiments.

3.1 EXPERIMENTAL WORK

The surface roughness of work specimen was measured by surface roughness tester, the Side rake angle of both the UT and CT HSS tools was measured using Universal Measuring Microscope and microstructure of both the UT and CT HSS tools was taken using Metallurgical Microscope, magnification ×100. All these tests were conducted at the Center for Research in design and manufacturing engineering (CRDM), First and last weight of the apparatuses was estimated with an electronic parity, Citizen Make, LC 0.01 mg. Power utilization was determined by assessing the current (amperes), voltage (volts) with Digital Tong-type Multi-meter, Speed of the workpiece was measured with Digital Tachometer, Model DT-2234.

3.2 TOOL AND CUTTER MACHINE

A device and shaper processor are utilized to hone processing cutters and device bits alongside a large group of other cutting instruments. The activity of this machine (specifically, the physically worked assortment) requires an elevated level of ability. The two principle abilities required comprehension of the connection between the crushing haggle metal being cut and information on instrument geometry.

Fig 1: Tool and cutter grinder operation

Fig 2: Cryogenic treatment

IV. RESULTS AND DISCUSSIONS

4.1 Comparison of Flank Wear for Conventional and New Single Point Cutting Tool

The Table 1 shows the observational readings of Flank wear in Cryogenic treated and untreated tools.

Sl. No.	Time (min)	Flank wear (mm)					
		Untreated HSS tool Rake angle			Treated HSS tool Rake angle		
		10˚	11◦	12◦	10◦	11◦	12◦
1	11.76	0.245	0.205	0.190	0.140	0.130	0.111

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2	23.52	0.270	0.220	0.198	0.165	0.146	0.135
3	35.28	0.290	0.236	0.210	0.180	0.175	0.156
4	47.04	0.309	0.258	0.228	0.188	0.184	0.179

Table 1: Comparison of flank wear test

From the above table, it is clear that the cryogenic treated a new single-point cutting tool having rake angle 120 has minimum flank wear compare to the conventional cryogenic treated single-point cutting tool.

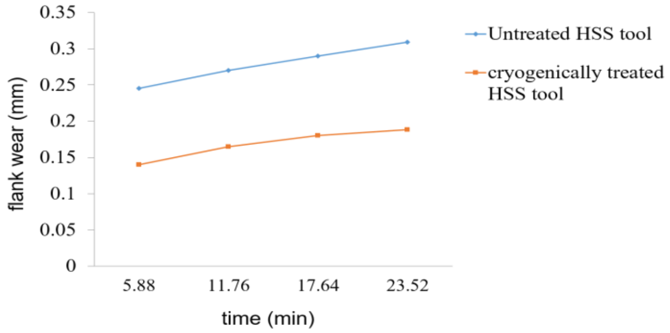


Fig 3: Graphical representation of flank wear/time for different rake angles of untreated single point cutting tool

From the above graphical representation, it is clear that the untreated a new single-point cutting tool having rake angle 120 has minimum flank wear compare to the conventional un-treated single-point cutting tool.

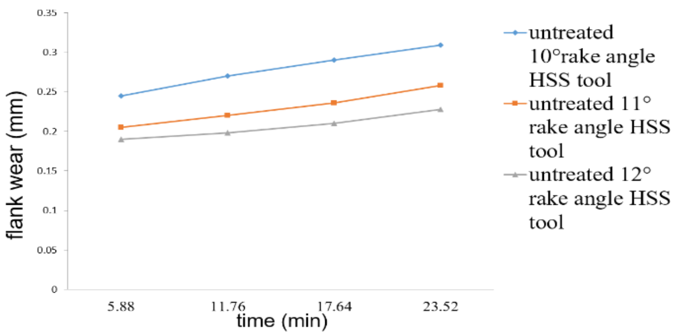
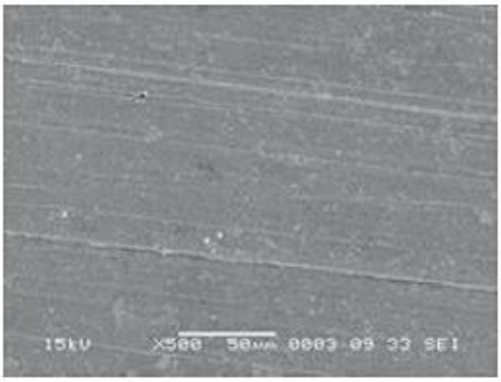


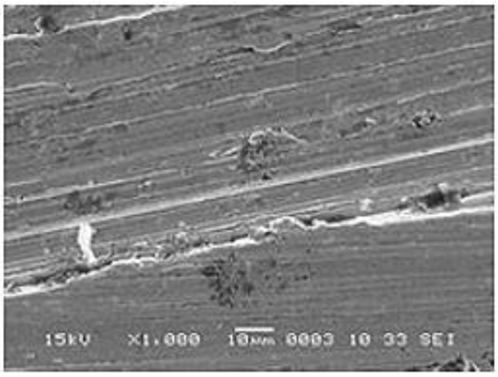
Fig 4: Graphical representation of flank wear/time for different rake angles of cryogenic treated single point cutting tool

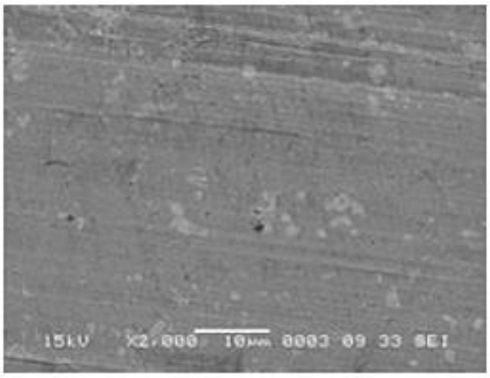
From the above graphical representation, it is clear that the cryogenic treated a new single-point cutting tool having rake angle 120 has minimum flank wear compare to the conventional cryogenic treated single-point cutting tool.

4.2 Comparison of Characterization by Sem Analysis

SEM was carried to study the microstructural changes in HSS samples before and after cryogenically treated. The figure 5 & 6 shows the cryogenically untreated and treated respectively with two different speeds S400 & S500.







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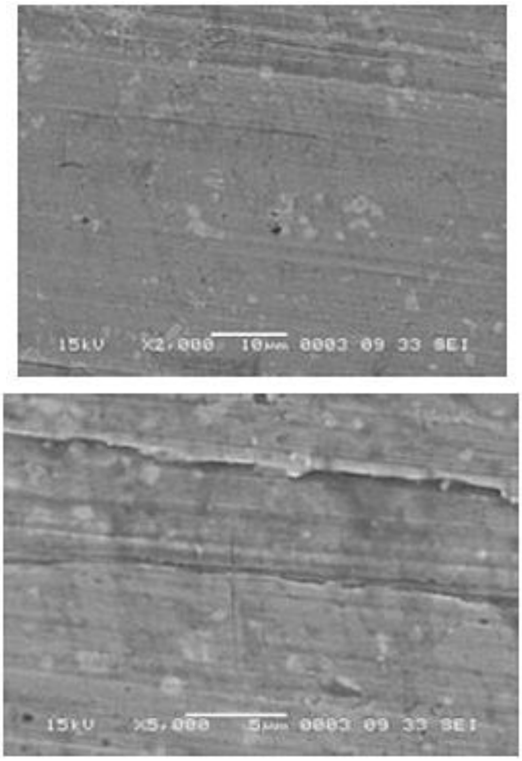
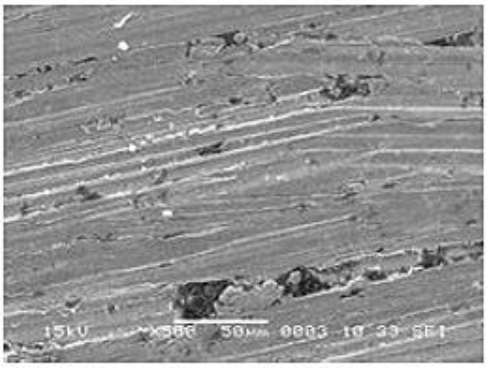
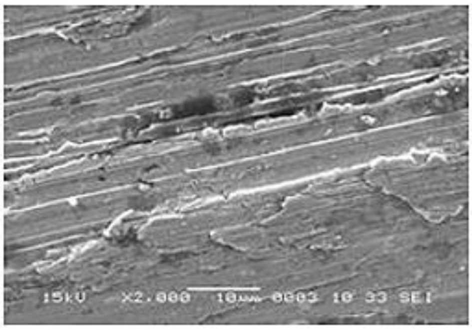


Fig 5: SEM results for HSS samples (Treated).





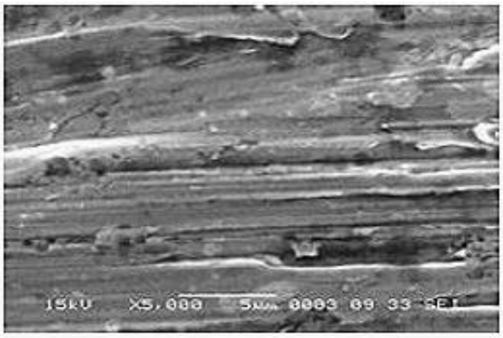


Fig 6: SEM Results for HSS samples (Untreated).

4.3 Comparison of Surface Roughness

There is a decrease in surface roughness by 5.51, 4.72, 3.22 Ra (micro/m) and 3.92, 4.21, 2.12, Ra (micro/m) for cryogenically treated HSS, and untreated HSS tool correspondingly in assessment to both tools. Hence it is apparent that there is an rise in work material finishing for cryogenically treated HSS tools due to the increasing rake angle of the single-point cutting tool.

S.NO	Machining time (min)	Length of operation (mm)	Tool condition	Surface roughness (Ra) um	
				Rake angle 11^0	Rake angle 12^0
1	5.88	550	Untreated tool	4.72	4.21
2	5.88	550	Treated tool	3.22	2.12

Table2. Surface Roughness

4.4 Comparison of Hardness

There is an increase in hardness by 44.5 to 57.5 BHN for cryogenically untreated HSS, and treated HSS tool respectively in comparison to both tools.

S.no	Tool condition	Hardness (BHN)
1	UNTREATED HSS	44.5
2	TREATED HSS	57.5

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5. CONCLUSION

Through this examination, cryogenic single point cutting HSS tool results such as surface roughness, flank wear; Hardness is superior to untreated single point HSS equipment. After cryogenic treatment, the performance of the equipment was pointedly increased. From the micrograph shown in the figures, and it can be understood that the microstructure of the HSS becomes more sophisticated, and the particles are evenly scattered after cryogenic treatment.

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