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"Impact of thermal treatment process over carbon based single point cutting tool"

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ABSTRACT

In this research work, we have found that tool wear rate of the materials of high-speed steel and Stainless steel of 440C Grade which are having optimum composition of carbon and other constituents. Here we have expounded the distinguishing characteristics of high-speed steel and Stainless Steel in respect to the tool wear. Subsequently, we have carried out heat treatment process, where two machined specimens were kept inside the muffle furnace once it attained required temperature, it was maintained at that temperature for a certain period of time and then cooled back to room temperature, we have conducted hardness test, tool wear test. In addition to these cutting operations have performed over mild steel workpiece.

Keywords: *High Speed Steel, Stainless Steel (SS440C), Wear Rate*

I. INTRODUCTION

In light of growing technology there are different facilities can able to acquire directly and indirectly from available resources. Earlier century, people were facilitated traditional technology to do desirable task but now it is wholly replaced by new modern technology daily human beings are fully depending on technology. Technology not only satisfies ethical task but it gives an idea how to discover new thing and how we need to take a control over new system. As far as newly discovered product rate of material is concerned the demanded product would have highest package in market as compared to exist one. So, in this connection as we know that there are various materials would have known for their best properties. In view of current technological aspects what we observed in the late nineties that were limited to certain extent. But now due to faster rate of growing technology our engineers

are well known across the world for their keen interest to take bold step to discover something. In the area of mechanical engineering several manufacturing systems have been developing since very long time those manufacturing process played vital role to enhance the value of product both in qualitatively and quantitively. An effective way of explanation is needed to disclose the mechanical properties of any metal or alloys. In order to alter the mechanical characteristics, there are various and several methods could be seen those are alloying process, Recrystallization Process and Heat Treatment process. However, some hindrances could be seen to achieve desirable mechanical characteristics. Many industrialists made investigation over cutting tool materials, thereby attaining desired properties over cutting tool materials heat treatment operations have been carried out. These operations have been made impact over cutting materials in increasing the hardness, toughness, tensile strength and other properties. When we talk about machining there are non-evicted things commonly encountered. Thus, the ratio of product outcome to product income may give us lesser productivity as we do not eradicate these problems. Before we met technology our ancestors were used to bring sharp tools which were being used to cut the materials and also used to kill the animals to lead the life. As technology grows, the human has facilitated different technological items which are used in engineering area. While performing machining over any metal or alloy by means of cutting tool at shear zone an enormous amount heat may be generated. As a result, cutting will take place. There are some factors shall consider into our account to perform cutting action. In machining era there are cutting speed, feed, depth of cut, the direction of cutting operation, type of metal, type of cutting tool material and other factors will be considered deeply. Some other aspects shall also be considered in order to out root the wearing of tool and machined surface. There are various machine tools are available in order to perform machining operation over any material those are Lathe Machine tool, Milling, Drilling, Grinding, boring, planning, and shaping etc... So in this connection being an engineer we have to take a keen and attentive look over cutting material rather than the type of work piece used for machining operation.

II. EXPERIMENTAL SET UP

A. Tool Material Selection

Any material which gets required shape because of cutting tool, so the choosing of material plays a crucial role for making cutting operations. The nominal compositions of High-speed steel and Stainless Steel is tabulated below. After obtaining required tool materials they are

cleaned by means of chemical solution in order prevent the accumulation of unwanted tiny particles over given work piece then it is subjected to heat treatment process.

Fig.1.1: High Speed Steel raw material

Fig.1.2: High Speed Steel raw material

Table 1: Nominal chemical composition of High-Speed Steel (HSS Steel)

Material	C	Mn	Si	Cr	Ni	Mo	W	V
High Speed Steel (HSS Steel)	1.05	0.40	0.45	4.50	0.3	5.50	6.75	2.20
Stainless Steel (SS440C)	0.08	2.00	1.00	18.0	0.045	12.0	---	---

B. Heat Treatment Process

Heat treatment is a process of combination of heating and cooling of a metal or alloy. By means of heat treatment the metal or alloys get required properties. So hardening operation was carried out above isothermal temperature in order to enhance the material property. In this respect, initially the machined specimens were kept inside the muffle furnace it was held above isothermal temperature line for certain period of time after that it cooled in water for

some time. It was allowed for cooling for some time as a result of that there is massive changes have been taken place over cutting tool materials. The muffle type heat treated furnace is shown in Fig.1.3. In the meantime, the hardness of a material is increased, it is known by making hardness test over the modified heat-treated high-speed steel and Stainless Steel.

Fig.1.3: Muffle Type of Heat-Treated Furnace

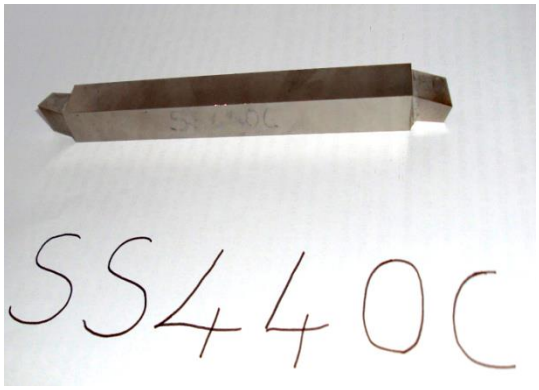

Fig.1.4: SS440C Heat Treated Finished Tool

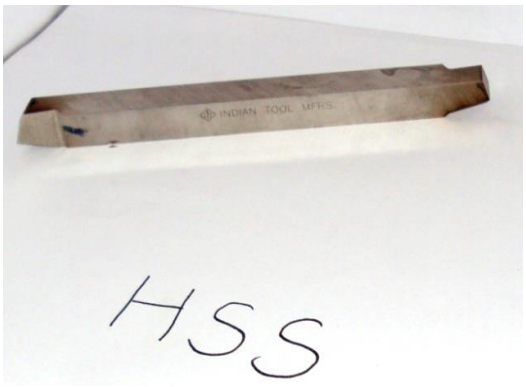

Fig.1.5: High Speed Steel Heat Treated Finished Tool

III. MATERIAL CHARACTERIZATION

A. Hardness Test

Fig.1.6: Rockwell Hardness Testing Machine

There are several hardness testing machines can be seen. Amongst all, Rockwell hardness test gives arbitrary readings. Unlike other hardness testing machines Rockwell hardness testing machine does not need surface preparation of the workpiece. Firstly, the workpiece was placed upon the machine, the dial in the machine can show any reading, further hand wheel was rotated, thereby workpiece moved up towards against to the ball indenter until needle on the dial reads zero this applies minor load. Later, major load was applied by means of pressing the crank which was located at right hand side of the machine. Further, the crank is turned in reverse direction thereby withdrawing major load but leaving minor load. Then hand wheel was rotated in turns workpiece was lowered. During this stage hardness of the workpiece is directly obtained from dial scale.

IV. RESULTS AND DISCUSSIONS

A. Tool wear

Concerning to tool wear, it is a rapid failure of material by means of indecorous Machinability conditions. As cutting speed of cutting tool increases the wearing of cutting will be greater. So, an optimum cutting speed is maintained to eradicate loss of tool. So as far as machining knowledge is concerned tool wear also depends upon the machining time as machining time goes on increasing the tool wear rate would be high. So, in this respect measurement tool wear is found by grooving and indentation method and by optical

method usually fitted with micrometer. The measurement of tool wear by optical microscope is shown in Fig.1.7.

Fig.1.7: Optical microscope with 8X magnification

The values of tool wear have been tabulated in table 3

Table 3: Tool Flank wear rate of High-Speed Steel and Stainless Steel (SS440C)

Work Piece	Cutting Material	Speed (RPM)	Feed (mm/Rev)	Depth of Cut (mm)	Time Elapsed (Min.)	Flank wear rate (mm)
Mild Steel	High Speed Steel	71	0.4	1.0	3	0.6
					6	0.8
					9	0.88
					12	1.3
					15	1.9
					Wear Rate: 1.26×10^{-4} m/min	
Mild Steel	Stainless Steel (SS440C)	71	0.4	1.0	3	0.3
					6	0.55
					9	0.66
					12	0.7
					14	0.79
					Attained Wear Rate:0.52×10^{-4} m/min	

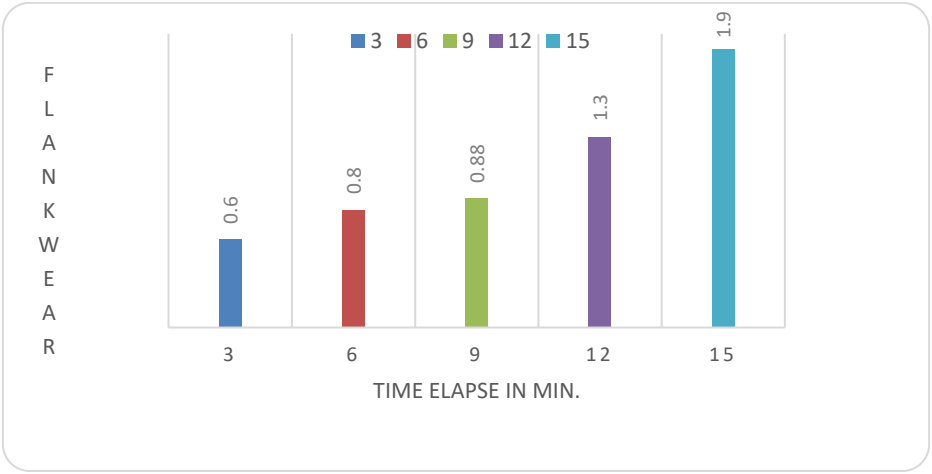

Fig.1.8: Flank wear rate on High Speed Steel (Max. Wear rate 1.26×10^{-4} m/min)

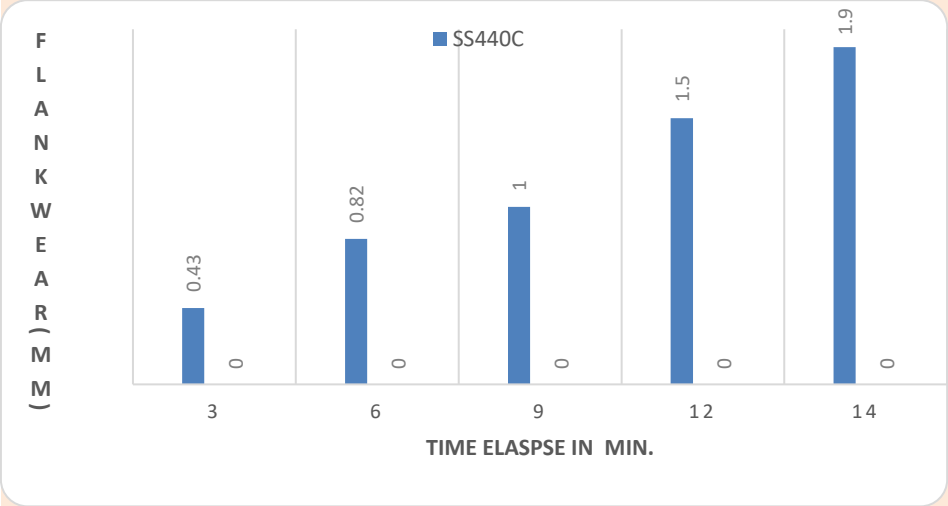

Fig.1.9: Flank wear rate on Stainless Steel (Max. Wear rate 0.52×10^{-4}m/min)

From the Figure 1.8 and 1.9 one can notice that the wear rate of a high-speed steel cutting tool has the lowest wear rate than Stainless Steel. As the machining time of both high-speed steel and Stainless-Steel cutting tool increases the wear rate also increased. In this respect the wear rate of high speed steel is measured by taking mild steel as a tested specimen the maximum wear rate was (**1.26×10^{-4} m/min).** Like high-speed steel, the wear rate of Stainless Steel is measured by taking mild steel as a tested specimen the wear rate is (**0.52×10^{-4}m/min).** At exactly **5 Minutes** the wear rate was more for high-speed steel cutting tool and at exactly **14.00** Minutes the wear rate is more Due to phenomenon of adhesion and diffusion would be more in Stainless Steel (SS440C) than high speed steel cutting tool.

CONCLUSIONS

1. The wear rate of High-Speed Steel is found higher than Stainless steel cutting tool.
2. After carrying out of heat treatment process the wear rate somewhat reduced
3. Diffusion and adhesion wear mechanism was observed.
4. At high cutting speed the High-Speed Steel is found that it has higher shear force than Stainless steel cutting tool.
5. Wear rate of Stainless-Steel cutting tool on mild steel work piece is lower than High Speed Steel.

FUTURE SCOPE

1. By the means of coating process, the life of the cutting tool would be increased.

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