JSESM

Journal of Scholastic Engineering Science and Management

January 2021, Volume 1, Issue 1, pp:14-22

"Influence of Hardening Process Over Modified Heat-Treated Carbon Steel Cutting Tool Materials"

[1]Mahadev Patil K, [2]Suresh Kumar

[1]Assistant Professor, [2]Associatet Professor

[1, 2]Department of Mechanical Engg.

[1,2]Visvesvaraya Technological University, Belagavi, Karnataka

Email: [1]mahadevpatilk23@gmail.com, [2]sureshb4all@gmail.com

ABSTRACT

In this research work, we have found that tool wear rate of the materials of high-speed steel and Titanium alloy which are having optimum composition of carbon and other constituents. Here we have expounded the distinguishing characteristics of high-speed steel and Titanium alloys 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 and aluminum workpiece.

Keywords: *High Speed Steel, Titanium alloy, Tool wear, Heat Treatment*

I. INTRODUCTION

Well, since very long-time research has been taking place in the field of mechanical engineering, as we know that when the material is subjected to abnormal stress plastic deformation of material will take place causes wearing of material. So, there are some inevitable problems routinely occurred while performing metal sawing or cutting works. Viz…deposition of chips over the machined surface it engenders the decreasing the life span of the tool, improper supply of lubrication, indecorous of cutting tool geometry and many more. Thus, these problems engender wearing of tool materials and it decreases the life span of the cutting tool material. Concerning to machining process there are some factors we have taken into the account to drive the cutting process. The cutting parameters like cutting speed,

feed, and depth of cut, machinability conditions, type of metal cutting operations these factors which enhance the cutting process. Besides, cutting tool possess required properties like hot or red hardness, high resistance towards wear, resistance towards to abrasion, high bonding strength, low diffusion and adhesion property and high thermal conductivity and low coefficient of friction and many more. Referring to cutting process even a hard cutting material which is made out by Titanium or molybdenum alloy can contemplate sundry amount of decrease in tool life and increase of tool wear. So most often an optimum cutting condition could be maintained while performing cutting operations. So, in this respect there are vast tool materials available based on composition of a material the wear of the tool and life span of the too depends. As far as machining knowledge is concerned a lot of unpreventable factors which impact over tool wear and tool life, in this work we performed cutting operations on known materials like mild steel and aluminum where cutting conditions are optimum. In order to promote the tool life and decrease the wear rate thermal treatment operation was carried out to increase the hardness of a cutting tool material. The detailed work has been mentioned in following section. In the conceptions of materials engineering the several heat treatment processes enhances the material properties and gives the best Possible results. However, as a part of research work, we were carried out hardening operation which is used to enhance the hardness property of a material and hardness of a material was measured out by means of hardness testing machines these matters have been mentioned in impending section. Apart from carbon other constituents have been used in cutting materials which are used to promote other desirable characteristics like resistance towards corrosion, adhesion, abrasion, and improve Machinability and durability characteristics and many more.

II. EXPERIMENTAL METHOD

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 Titanium alloy 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: Ti-6Al-4V raw material

Fig.1.2: High Speed Steel raw material

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

Material	C	Mn	Si	Cr	Ni	Mo	W	V
High Speed Steel	1.05	0.40	0.45	4.50	0.3	5.50	6.75	2.20

In the same manner, the chemical composition of Titanium alloy (Ti-6Al-4V) are mentioned below table.2

Table 2: Nominal metal composition of Titanium alloy (Ti-4V-6Al)

Material	Al	V	Ti
Titanium	6.0	4.0	Balance

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.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 Titanium alloy.

Fig.1.3: Muffle Type of Heat-Treated Furnace

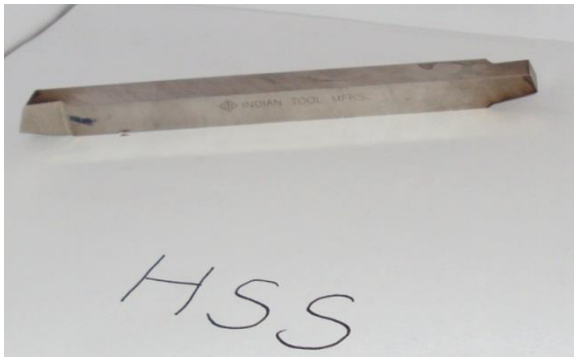

Fig.1.4: High Speed Steel Heat Treated Finished Tool

Fig.1.5: Ti-6Al-4V 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.

B. 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 microscopic 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

Table 3: Tool Flank wear rate of High-Speed Steel and Titanium alloy

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**
					Max. Wear Rate: 1.26×10^{-4} m/min	
Al	**Titanium Alloy**	71	0.4	1.0	**3**	**0.3**
					6	**0.55**
					9	**0.66**
					12	**0.7**
					15	**0.79**
					18	**1.0**
					21	**1.4**
					24	**1.6**
					27.33	**1.9**
					Max. Wear Rate: 1.35×10^{-4} m/min	

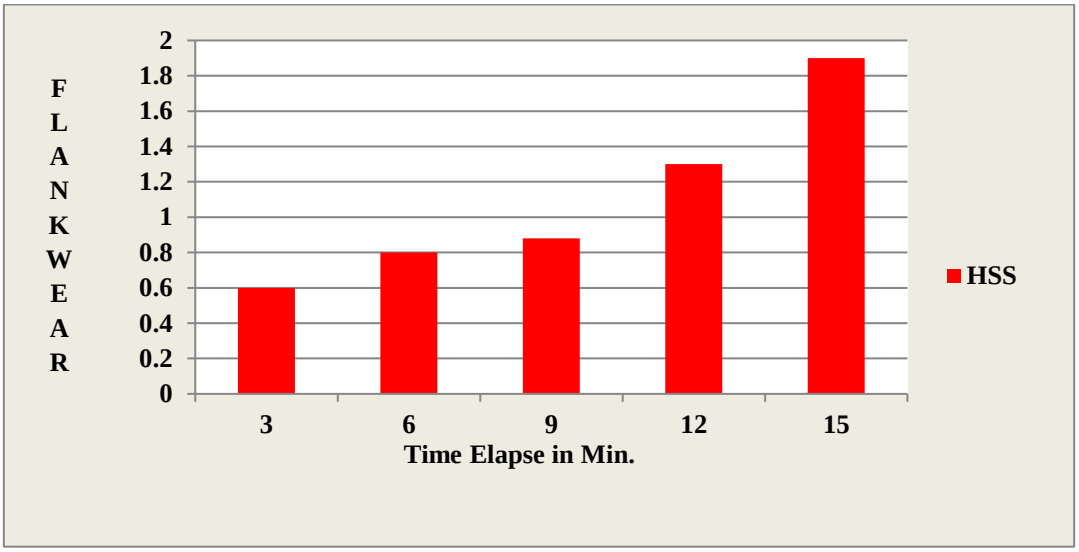

Fig.1.8: Rate of flank wear on High Speed Steel (Max. Wear rate 1.26×10^{-4} m/min)

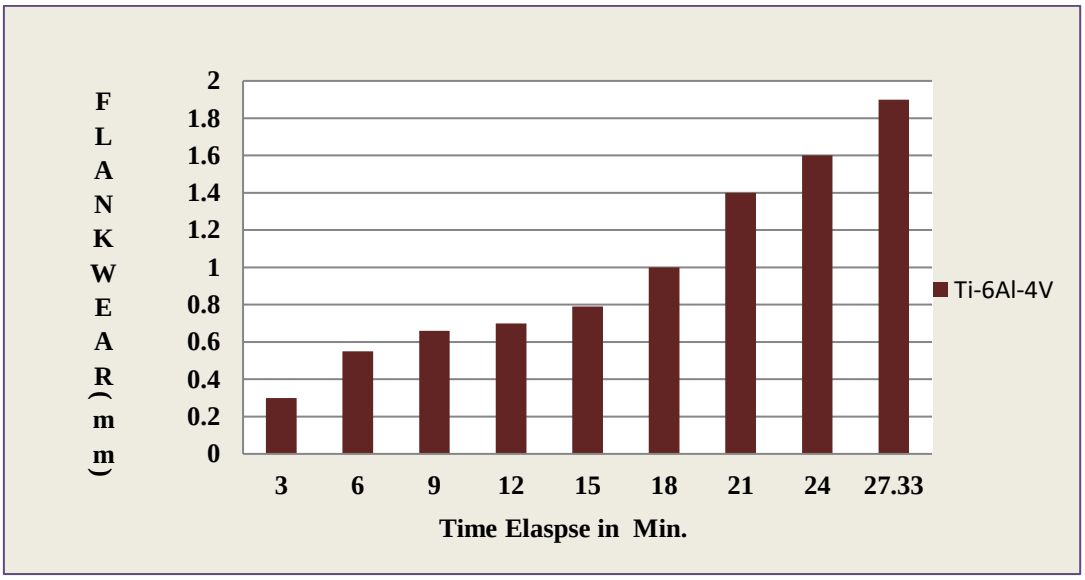

Fig.1.9: flank wear rate on Ti-6Al-4V (Max. Wear rate 1.35×10^{-4}m/min)

From the Fig.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 titanium alloy. As the machining time of both high-speed steel and titanium alloy 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 titanium alloy is measured by taking aluminum as a tested specimen the maximum wear rate is **(1.35×10^{-4}m/min).** At exactly 5 Minutes the wear rate was more for high-speed steel cutting tool and at exactly 27.33 Minutes the wear rate is 1.9. Due to phenomenon of adhesion and diffusion would be more in titanium alloy than high speed steel cutting tool.

CONCLUSIONS

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

FUTURE SCOPE

1. By the method of coating process, the life span of the cutting tool shall be increased.

REFERENCES

[1] Dr. Viktor P. Astakhov, Tool Geometry: Basics.

[2] Arshinov V. and Alekseev G. (1976), Metal Cutting Theory and Cutting Tool Design, Chapter 7 Mir Publishers, Moscow.

[3] David. T. Reid Fundamentals of Tool Design 3rd edition chapter 1.

[4] Pradeep Kumar Patil, A.I. Khandwawala" analytical investigation of the cutting forces on single point cutting tool" new coating developments for high performance cutting tools.

[5] "Life enhancement of single point cutting tool by hard Facing and cryogenic treatment" Hazoor S. Sidhu a*, Kumar Gauravb, *Rakesh Bhatiaa National Conference on Advancements and Futuristic Trends in Mechanical and Materials Engineering (February 19-20, 2010).

[6] M.J. Jackson a,*, G.M. Robinson b, J.S. Morrell b Machining M42 tool steel using nanostructured coated cutting tools received 03.04.2007; published in revised form 01.07.2007.

[7] Fuzzing modelling of a single point lathe cutting tool. R. Marumo*, M. T. Letsatsi and O. S. Motsamai: Journal of Mechanical Engineering Research. Vol. 3(7), pp. 264–288, July 2011; ISSN 2141 - 2383 ©2011.