© 2017 IJSRST | Volume 3 | Issue 7 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Comparative Performance Analysis of Cryogenic Treated Carbide Tools

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ABSTRACT

Tool wear became important issue for industries for sustainable manufacturing. Tool life became improve by using method such as optimal cutting condition, cutting fluid, coatings and heating process. Another method tool life became improvement such as cryogenic treatment .Metal cutting operation it became necessary to reduce tool wear and improve the product quality. A comparative investigation of the Tool wear behaviour of with cryogenically tungsten carbide inserts and without cryogenically tungsten carbide inserts in dry machining. The tungsten carbide inserts square-shaped and cryogenic has done at −196 °C. Experimental has designed by Taguchi's L9 orthogonal array. ANOVA analysis machining parameters has affected on the tool wear. The analyzed result was using ANOVA and signal-to-noise ratios (S/N) and with cryogenic tungsten carbide inserts better result compared to that without uncryogenic tungsten carbide inserts in machining conditions .In cryogenic Cutting speed has maximum affected on tool wear .

Keywords : Analysis, with Cryogenic and uncryogenic treatment carbide tools, Tool wear.

I. INTRODUCTION

These material is a most important material. These material is very used different field as chemical industries, gear industries etc. Application of this material as chemical plant, airspace, Gear Company, pipeline industries. Mechanical properties of this material high strength, good yield strength, high toughness .physical properties of this material chemical resistance, thermal conductivity, electrical conductivity [1]. Therefore the requirement of optimal parameter for this material. Analysis of cutting parameters is most important for the reducing manufacturing cost and improvement of surface quality, Tool life must be increase by cutting fluid and optimal cutting parameters, heat process and coatings [2]. AISI 316 stainless steel are nicle-based(e.g.superalloys) and low thermal conductivity[3].Tool wear resistance are high during of cutting materials and cryogenic process has increment hardness of cutting tool[4]. Cemented caride insert coated such as improvement hardness and coated can be reduce flank wear [5]. Cutting parameter has affected on input parameter.Cutting tool was coated by TIC/TICN/TIN and TIC/TICN/Al_2O_3 under dry machining condition [6]. ANOVA analyzed cutting parameter has affected on the tool wear ,MRR durning the dry machining[7]. Compared the conventional dry and wet machining processes with used cutting fluid and constant speed and feed, depth of cut [8]. In recent years many technologies has used and obtained optimal parameter[9].Cryogenic is a conventional cooling process has used to improve hardness of material.[10].Deep cryogenic temperature has used from -125 °C to -196 °C and improve hardness [11,12]. Cutting parameter has effected on surface roughness. Many cutting parameter are used as rake angle, nose radius and speed, feed ,depth of cut etc. Taguchi method has used by experimental design and optimal value. It has conducted cutting speed effected on R_a[13]. After the study observed that increase speed and decrease in feed rate has obtained minimum Surface roughness.[14]. Cryogenic treatment are used for improve of properties of tool. Cryogenic temperature are used for made of hard tool and temperature limit highest has used -196 ˚C[15].In present years, new method cryogenic process, Many research has been done on this process and results have provides for reduced tool wear as compared with another process[16]. It has observed that cryogenic tungsten carbide inserts by applying coolant and reduce the tool wear [17]. It has investigation of the turning of C45steel, the tool life of cemented carbide inserts improve of 20%to 36% by cryogenic treatment at196 ˚C for38h [18].

II. EXPERIMENTAL CONDITIONS AND PROCEDURES

Experiments were conducted to investigation of the tool wear with respect to machining time. Uncryogenic and cryogenic tungsten carbide inserts has used for machining of AISI 316 steel (36 ± 2 HRC) in dry condition. The tool wear has been measured by control vision machine. In this study, parameter range (v = 70, 90,110 mm/min, f = 0.24, 0.36,0.48 mm/rev and doc = 0.4,0.8, 1.2 mm) had taken to measured performance both inserts. The turning tool wear were measured and compared. Experimental conditions, measurements and the procedure used for the investigation

2.1. TEST SPECIMEN

AISI 316 stainless steel has used for test of composition and length 100 mm and 30 mm diameter. The work piece chemical composition has measured by Energy dispersive spectroscopy (EDS).Work piece material hardness has found to be 36 ± 2 HRC .It has measurement by hardness tester. Work piece chemical composition Shown in figures 1.

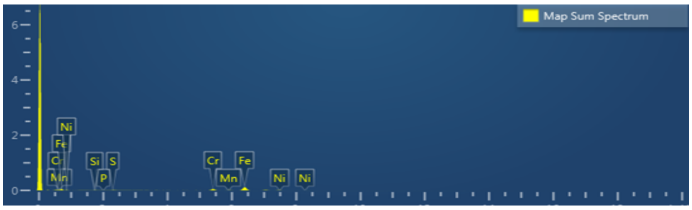

Figure 1 : Photograph of Work piece material composition

2.2. MACHINE TOOL

Experiment of hard turning has been conducted on a conventional lathe machine (OKUMA JAPAN). Lathe machine spindle speed has done from 35 to 1800 RPM. Shown in fig. 2.

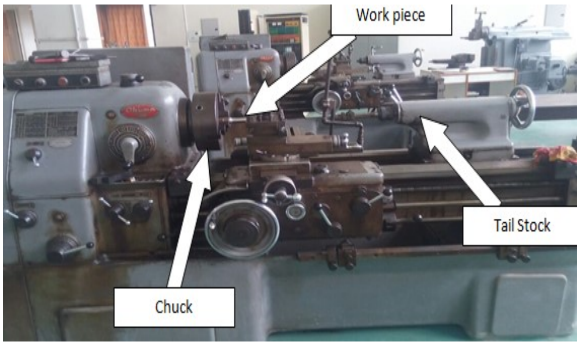

Fig-2: Photograph of Lathe Machine

2.3. CUTTING INSERTS

Uncryogenic tungsten carbide inserts and cryogenic tungsten carbide inserts (manufactured by TAEGU TEC) of ISO designation CNMG 120408 FA grade - TT5100 (squared shaped insert) have been used for experimentation. Deep cryogenic treatment temperature -196 °C, these temperature has held generally for 48h and then gradually heated to room temperature. Inserts are mounted on a tool holder designated by ISO as PCLNR2020 K12 figures 3.

Fig.-3: Photograph of cutting inserts

2.4. CUTTING CONDITIONS

The cutting condition for finish machining under parameter condition is shown in below.

Table 1: Parameter condition

Cutting Conditions For Machining	
Machine Used	Conventional Lathe
Work Material	AISI 316 Stainless Steel
Dimension Of Work Piece	Dia.30mm And Length Of Cut 50mm
Design Of Experiment	Taguchi Design Procedure

2.5 .TOOL WEAR MEASUREMENT

Tool wear has main parameter for every machines cost. Tool wear has directly affected on the cutting process and machine-finishing precision, the efficiency and the economic efficiency. Machine Vision system is used for measuring the Tool wear as show figures 4.

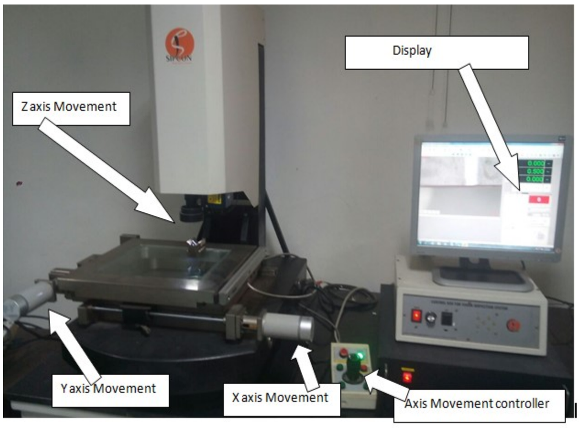

Fig.4: Machine Vision System

III. RESULTS AND DISCUSSION

The experimental results of the flank tool wear different cutting speed and feed , depth of cut during machining for both cryogenic and uncryogenic tungsten carbide inserts are presented in Table 4,5.Signal to noise(S/N) ratios has used for performance measurement is to develop products. ANOVA analyzed has affected factor on tool wear. The summary of experimental designed by Taguchi L9 is presented below:

TABLE -2:

Test Run	Cutting Speed(mm/min)	Feed (mm/rev)	Depth of cut (mm)
1	70	0.24	0.4
2	70	0.36	0.8
3	70	0.48	1.2
4	90	0.24	0.8
5	90	0.36	1.2
6	90	0.48	0.4
7	110	0.24	1.2
8	110	0.36	0.4
9	110	0.48	0.8

IV. EXPERIMENTAL VALUE

Results of uncryogenic and cryogenic tungsten carbide inserts are Tool wear for hard machining of AISI 316 stainless steel.

TABLE -3:

Test Run	Experimental value	
	Uncryogenic Toolwear (μm)	cryogenic Tool wear (μm)
1	78.67	76.50
2	77.90	76.40
3	79.40	77.40
4	72.60	72.30
5	74.67	73.60
6	80.50	78.34
7	70.70	70.40
8	72.90	72.64
9	75.80	73.45

4.1. SIGNAL TO NOISE RATIOS

It was used to analyze best parameter for the cutting process. Cutting parameter that corresponds to highest value of 'S/N ratio' is the best level of combination. The best parameter setting is found in cryogenic to be level **1** cutting speed and level feed 2, level **3** depth of cut for minimum tool wear and cutting speed has most effect on tool wear .The best parameter setting is found in uncryogenic to be level **2** feed and level **1** cutting speed, level **3** depth of cut for minimum tool wear and cutting speed has most effect on tool wear.

TABLE 4: uncryogenic tool wear response table based on S/N ratios

Level	Cutting Speed(mm/min)	Feed (mm/rev)	Depth of cut (mm)
1	37.91	37.37	37.76
2	37.60	37.52	37.55
3	37.28	37.90	37.48
Delta	0.64	0.53	0.28
Rank	1	2	3

TABLE 5: cryogenic tool wear response table based on S/N ratios**.**

Level	Cutting Speed(mm/min)	Feed (mm/rev)	Depth of cut (mm)
1	37.70	37.27	37.59
2	37.47	37.41	37.39
3	37.16	37.66	37.35
Delta	0.54	0.39	0.24
Rank	1	2	3

4.2. MAIN EFFECT PLOT ANALYSIS

MINITAB-16 software package has used for analyzed cutting parameter. The main effect of the plot is shown in fig.5,6 .It show the variation of every single response with three parameter such as cutting speed(A) and depth of cut(C) ,feed rate(B). In the plot x-axis value of signifies of each process parameter and y-axis value signifies of the response value. Horizontal line has indicated mean of the response. Main effect plot has analyzed the optimal parameter conditions to get cryogenic tool wear. Main effect plot has indicated best parameter for minimum tool wear are cutting speed at level 1

(110 mm/min), feed at level 2 (0.24 mm/rev), depth of cut at level 3 (1.2 mm) and best parameter for minimum uncryogenic tool wear are cutting speed at level 1(110 mm/min), feed at level 2 (0.24 mm/rev), depth of cut at level 3 (1.2 mm)as shown figures 5, 6**.**

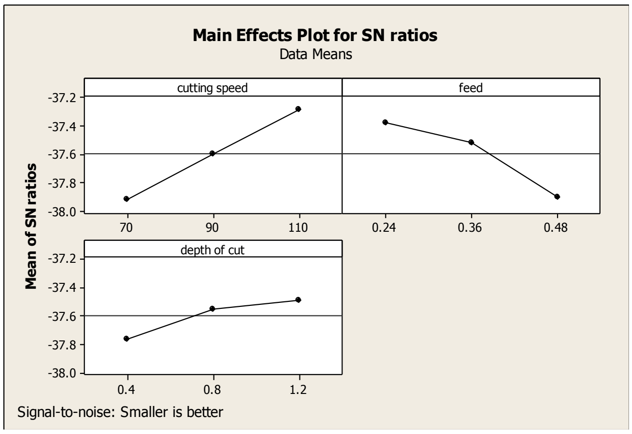

Fig-5: Effect of turning parameter on uncryogenic tool wear

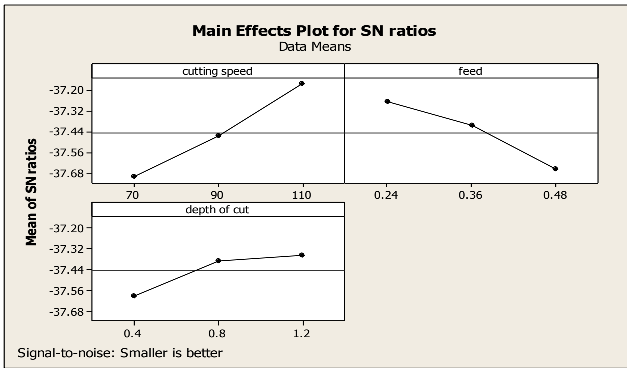

Fig-6: Effect of turning parameter on cryogenic tool wear

4.3. ANOVA AND THE EFFECTS OF FACTOR

The general linear model procedure has used to conduct an ANOVA test which requires a response or measurement taken and the factor on which the response varies. In order to find out statistical significance of various factor like cutting speed (A), Feed rate (B), and depth of cut (C), analysis of variance (ANOVA) is performed on experimental data. Table 6,7 shows the result of ANOVA for cryogenic and uncryogenic tool wear. The P-column of the Table 6 and 7, indicated the percentage contribution of the control factor and their interaction on the performance output. Similar from Table 6 it has observed that for the uncryogenic tool wear among three value of factor the percentage contribution of cutting speed is 0.80, feed have 0.104 and Depth of cut has 0.286, thus cutting speed will have the maximum influence on tool wear.

TABLE -6: ANOVA for uncryogenic tool wear

Level	DF	Seq.SS	Adj. SS	Adj. MS	F	P
Cutting speed	2	45.762	45.762	22.881	11.56	0.80
Feed	2	33.935	33.935	16.968	8.57	0.104
Depth of Cut	2	9.880	9.880	4.940	2.50	0.286
Residual Error	2	3.958	3.958	1.979		
Total	8	93.536				

TABLE -7: ANOVA for cryogenic tool wear

Source	DF	Seq. SS	Adj. SS	Adj. MS	F	P
Cutting Speed	2	31.9447	31.9447	15.9723	24.30	0.040
Feed	2	17.1707	17.1707	8.5853	13.06	0.071
Depth of cut	2	7.3264	7.3264	3.6632	5.57	0.152
Residual error	2	1.3147	1.3147	0.6573		
Total	8	57.7565				

From Table 7, it can be observed that for cryogenic tool wear among the three value of factor the percentage contribution of Feed rate is 0.071, depth of cut has .152 and Cutting speed has .040, thus cutting speed has will have the maximum influence on tool wear.

V. COMPARISION RESULT

Comparison between cryogenic tungsten carbide inserts and uncryogenic tungsten carbide inserts behavior of tool wear in dry machining. The result of the Taguchi analysis after the optimal parameter has obtained in the cryogenic. The minimum tool wear characteristics obtained was at cutting speed 110 mm/min and depth of cut 1.2 mm, feed 0.24mm/rev.

VI. CONCLUSIONS

The conclusions can be obtained from this investigation on turning of hardened AISI 316 stainless steel using uncryogenic and cryogenic tungsten carbide inserts at different cutting parameters: The following conclusion can be drawn based on the analyses of the turning operations:

- ✓ From S/N ratio and graph analysis the optimal setting of the influencing parameter for tool wear in cryogenic are: cutting speed 110 mm/min and feed 0.24 mm/rev and depth of cut 1.2 mm
- ✓ In uncryogenic minimum tool wear characteristics obtained was at cutting speed 110 mm/min and depth of cut 1.2 mm, feed 0.24 mm/rev.
- ✓ From ANOVA in cryogenic ,it is found that in turning, cutting speed are the most influencing variables for altering tool wear .
- ✓ From ANOVA in uncryogenic it is found that in turning, cutting speed are the most influencing variables for altering tool wear

VII. REFERENCES

[1]. Prajwalkumar M. Patil , Rajendrakumar V. Kadi , Dr. Suresh T. Dundur,Anil S. Pol ,"Effect of Cutting Parameters on Surface Quality of AISI 316 Austenitic Stainless Steel in CNC Turning", International Research Journal of Engineering and Technology, Vol .2,2015,pp.1453-1460.

[2]. M.Narasimha,R.ReijiKumar,Achamyelehaemro Kassie ,"Performance of Coated Carbide Tools", The International Journal Of Engineering And Science, Vol .2, 2013, pp.47-54.

[3]. IhsanKorkut , Mustafa Kasap , Ibrahim Ciftci, UlviSeker, "Determination of optimum cutting parameters during machining of AISI 304 austenitic stainless steel", Materials and Design,Vol 25, 2004; pp. 303-305.

[4]. IlhanAsilturk, SuleymanNeseli, "Multi response optimization of CNC turning parameters via

Taguchi method-based response surface analysis", Measurement ,Vol.45, 2012; pp. 785-794.

[5]. P. Marimuthu and K. Chandrasekaran," Experimental Study On Stainless Steel For Optimal Setting Of Machining Parameters Using Taguchi And Neural Network", ARPN Journal of Engineering and Applied Sciences, Vol. 6,2011, pp.119-127.

[6]. P. Marimuthu and K. Chandrasekaran," Experimental Study On Stainless Steel For Optimal Setting Of Machining Parameters Using Taguchi And Neural Network", ARPN Journal of Engineering and Applied Sciences, Vol. 6,2011, pp.119-127.

[7]. R. Suresh,S. Basavarajappa and G.L. Samuel," Some studies on hard turning of AISI 4340 steel using multilayer coated carbide tool",journal homepage: www.elsevier.com/locate/measurement, Vol. 45,2012, pp.1872-1884.

[8]. Ashok Kumar Sahoo and Bidyadhar Sahoo ,"Experimental investigations on machinability aspects in finish hard turning of AISI 4340 steel using uncoated and multilayer coated carbide inserts", journal homepage:www.elsevier.com/locate/measurement , Vol. 45,2012, pp.2153-2165.

[9]. Murat Sarıkaya and Abdulkadir Gullu," Taguchi design and response surface methodology based analysis of machining parameters in CNC turning under MQL", journalhomepage:www.elsevier.com/locate/jclepro, Vol. 46,2014, pp.604-606.

[10]. P. Marimuthu and K. Chandrasekaran, 2011," Experimental Study On Stainless Steel For Optimal Setting Of Machining Parameters Using Taguchi And Neural Network", ARPN Journal of Engineering and Applied Sciences, Vol. 6, pp.119-127.

[11]. T.V.S. Reddy, B.S. Ajaykumar, M.V. Reddy and R. Venkataram,2007 ,"Improvement of tool life of cryogenically treated P-30 tools",Proceedings of the International Conference on Advanced Materials and Compositees (ICAMC-2007) at National Institute for Interdisciplinary Science and Technology, CSIR, Trivandrum, India, pp. 457-460.

[12]. A.Y.L. Yong, K.H.W. Seah, M. Rahman,2007 ," Performance of cryogenically treated tungsten carbide tools in milling operations", Int. J. Adv. Manuf. Technol.Vol 32 ,pp. 638-643.

[13]. Vishal Sardana, Achintya, Ranganath M. S. 2016," Analysis Of Surface Roughness During CNC Turning Using Taguchi And Response Surface Methodology", IOSR Journal of Engineering, Vol. 6, Issue 2, pp. 59-70.

[14]. Muhammad Yasir, Turnad Lenggo Ginta, Bambang Ariwahjoedi,2016, Adam Umar Alkali, and Mohd Danish ,"Effect Of Cutting Speed And Feed Rate On Surface Roughness Of AISI 316l SS Using End-Milling", ARPN Journal of Engineering and Applied Sciences, Vol. 11, pp. 2496-2500.

[15]. Nursel Altan Ozbek , Adem Cicek , Mahmut Gulesin , Onur Ozbek,2014 ,"Investigation of the effects of cryogenic treatment applied at different holding times to cemented carbide inserts on tool wear", International Journal of Machine Tools & Manufacture,Vol .86,pp.34-43.

[16]. Z. Palmai, 1987" Cutting temperature in intermittent cutting", Int. J. Mach. Tools Manuf., Vol .27 , pp.261-274.

[17]. N.R. Dhar, S. Paul, M.B. Chattopadhyay,2001, "Beneficial effects of cryogenic cooling over dry and wet machining on tool wear and surface finish in turning AISI 1060 steel, J. Mater. Process. Technol. Vol.166 , pp. 44-48.

[18]. S. S Gill,H. Singh, R.Singh,J.Singh,2011, "Flankwearandmachiningper formance of cryogenical lytreated tungstencar bideinserts", Mater. Manuf. Process.Vol.26 ,pp. 1430-1441.