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V. R. Kagade

Department of Mechanical Engineering, Shree Tuljabhavani College of Engineering, Tuljapur -413 601,
vijaykagade@rediffmail.com

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Experimental investigation of turning operation using carbide inserts

V. R. Kagade^{1#}, R. R. Deshmukh²

¹Department of Mechanical Engineering, Shree Tuljabhavani College of Engineering, Tuljapur -413 601

²Department of Mechanical Engineering, Jawaharlal Nehru Engineering College, Aurangabad-431 006

vijaykagade@rediffmail.com

Abstract: This paper presents an investigation on the optimisation and the effect of cutting parameters on multiple performance characteristics (work piece surface roughness, spindle load) obtained by turning operations. A CNMG 09 03 08-PF carbide insert as tool and the HCHC steel as work piece material were used in experiments. The work piece material was machined under different settings of feed rate, depth of cut, cutting speed on a CNC lathe model-TL1 (HAAS). The results showed that cutting speed and feed rate were the dominant variables on multiple cutting performance characteristics. An optimum parameter combination was obtained by using experimental analysis.

Keywords: Surface roughness, spindle load, cutting parameters

I. INTRODUCTION

The materials having high-tensile strength and resistance to wear and impact, which are frequently used for drawing dies, blanking dies, forming dies, bushings, gauges, etc., are generally difficult to machine. HCHC-High carbon high chromium steel is one of these materials. For the machining of High carbon high chromium steels, the cutting tool materials must be harder than the work piece materials. These types of materials can be machined with carbide tools [1]. Among the cutting parameters affecting machining variables for steel, speed has maximum effect & depth of cut has minimum effect. Tool tip temperature increases with increase in cutting speed. At high speeds, surface finish is least affected. Surface finish deteriorates at high feed rates; hence to obtain good surface finish, feed rate may be kept low. At low speeds cutting force are high & tendency of work material to form a built up edge is also stronger. At lower speeds, surface roughness increases with increasing feed but at higher speeds surface roughness is less dependent on feed [2]. The Taguchi parameter design method is an efficient experimental method in which a response variable can be optimized, given various control and noise factors, and using fewer experimental runs than a factorial design [3].

II. EXPERIMENTAL DETAILS

This experiment was conducted using the hardware listed in Table I on CNC lathe machine as shown in figure 1. A Cylindrical bar of HCHC steel (length 75 mm, diameter 70 mm) was used as work piece to carry out experiments on CNC lathe by a CNMG 09 03 08-PF carbide insert as cutting tool.

TABLE I
HARDWARE LIST

Sr. no.	Item	Specifications
1	CNC lathe	Model-TL1 (HAAS) Spindle: Max. Speed- 2000 rpm; Torque- 136 Nm @ 375 rpm; Max. Power Rating – 5.59 KW; Spindle Nose- A2-5; Spindle Bore Dia.-59 mm Travels & Feed rates: X-axis- 209 mm; Z-axis- 762 mm; X-axis Max. Thrust- 133.772 KN; Z-axis Max. Thrust- 886 KN; Rapids on X-axis- 1.9 m/min; Rapids on Z axis- 308 m/min General: Weight- 1860 Kg; Power requirement- 9 KVA ;1-phase : 240 V @ 40A; 3-phase : 208 V
2	Surface roughness measurement device	Hommel werke Surface Tester- Measures Ra in μ m;
3	Cutting tool inserts	CNMG 09 03 08-PF

III. RESULTS & DISCUSSIONS

Work piece material HCHC-High Carbon High Chromium contains C-1.5% or more than 2%, Cr-12%, Mo-1% & some traits of W & V. It can maintain sufficient hardness up to 500 °C due to presence of alloy carbides [4]. It has got Low thermal conductivity. It is difficult to machine. It has got good wear resistance [5]. It is observed that while machining HCHC work piece material continuous chips are formed. From Table II which shows

experimental data related to surface roughness characteristics three graphs are plotted using MS Word 2007 software application.

Fig. 1 CNC Lathe

TABLE II
EXPERIMENTAL DATA RELATED TO SURFACE ROUGHNESS CHARACTERISTICS

Graph No.	Sr. No.	Speed in RPM	Feed in mm/rev	Depth of cut in mm	Surface roughness in microns (μm)			Spindle Load in KW
					Rmax	Rz	Ra	
I	1	1700	0.1	0.1	0.0	0.0	0.0	0.5
	2	1800	0.1	0.1	0.0	0.0	0.0	0.6
	3	1900	0.1	0.1	0.0	0.0	0.0	0.6
II	4	1900	0.1	0.1	0.9	0.2	0.0	0.7
	5	1900	0.2	0.1	4.62	11.1	2.1	0.9
	6	1900	0.3	0.1	6.8	6.4	1.5	1.0
III	7	1900	0.1	0.1	4.80	3.98	0.82	0.6
	8	1900	0.1	0.2	4.82	4.42	0.84	0.8
	9	1900	0.1	0.3	5.52	4.74	0.86	1.1

It is observed from the Graph I of Ra Vs Speed when Feed=0.1 mm/rev & Depth of Cut=0.1 mm that when feed & depth of cut are kept constant & only speed is increased continuously after certain maximum value of 1700 rpm then we can obtain almost negligible value of surface roughness.

Graph: -I Ra Vs Speed Graph when Feed=0.1 mm/rev & Depth of Cut=0.1 mm

From graph II of Ra Vs Feed when Speed=1900 RPM & Depth of Cut=0.1 mm it is observed that when speed & depth of cut are kept constant & only feed is feed rate i.e. 0.2 mm/rev & after this as feed increases then surface roughness decreases.

increased continuously then surface roughness also increases continuously up to certain higher value of

Graph: -II Ra Vs Feed Graph when Speed=1900 RPM & Depth of Cut=0.1 mm

From graph III of Ra Vs Depth of Cut when Speed=1900 RPM & Feed=0.1 mm/rev it is observed that when speed & feed are kept constant & only depth of cut is increased continuously then surface roughness also increases continuously. Also as speed increases continuously the spindle load is also increases continuously. Maximum value of spindle load occurs when value of depth of cut is high.

Graph: - III Ra Vs Depth of Cut Graph when Speed=1900 RPM & Feed=0.1 mm/rev

IV CONCLUSIONS

Among the cutting parameters affecting the surface roughness for HCHC steel, speed has maximum effect & depth of cut has minimum effect. At high speeds, surface finish is least affected. At low speeds surface roughness increases with increasing feed but at higher speeds surface roughness is less dependent on feed. Hence from the above experimental investigation it is found that optimum values of cutting parameters for machining of HCHC work piece material using a CNMG 09 03 08-PF carbide insert as cutting tool are, speed= 1700 rpm or more, feed= 0.1 mm/rev, & depth of cut= 0.05 to 0.1 mm.

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