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Comparative analysis of wear rate of coated HSS tool and non-coated HSS tool by using CR-ZN-NI

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ABSTRACT

A research program was conducted to study tool wear on uncoated and coated high speed steel (HSS) for fluted end mill cutters. These cutters were used to machine aisi 4340 steel at axial and radial engagements. All the machining was carried out using production conditions with the process periodically interrupted to carefully measure the wear condition of the cutting tool. Cutting conditions were carefully chosen so that a linear wear model for the useful life of the cutting tool could be statistically tested. One phase of testing used uncoated tools from different suppliers and the no stationary linear wear model provided a stochastic representation to determine tool quality using reliability and economic measures. Another phase used the coated tools and a stationary linear wear model to relate force, power, specific cutting energy, and mechanistic model parameters to service life measures.

Keywords: Nickel Coating, Chromium Coating, Zinc Coating Wear Rate, HSS Tool

INTRODUCTION

High Speed Steel (HSS) tools have been extensively employed for machining of different kind of materials through the past decades. HSS tools show great toughness in comparison to other tool materials and capable of withstanding against the cyclic or intermittent loading and unloading. For this reason, they are primarily used for cutting operations at which interrupted or intermittent cutting is likely to occur. These include operations such as milling, drilling, broaching, and tapping. High speed steels are also appropriate for producing tools of complex shape such as helical milling, drilling, broaching, reaming, and tapping tools. However, when it comes to machining of hard-to-cut materials such as chromium, zinc and nickel are coated by using physical vapour deposition in (HSS) tools and predict the wear nature and hardness. Chromium as a coating for tool steels has been available widely since the last decade and is enjoying increasing attention and application in tool industries. Coated and uncoated carbides are widely used in the metal-working industry and provide the best alternative for most machining operations. When machining using carbides under typical cutting conditions, the gradual wear of the flank and rake faces is the main process by which a cutting tool fails. It carried out tool wear investigations on some cutting tool materials. Plotted tool life curves using the flank wear criterion and obtained that the tool life of carbides decreased quickly at higher speed. The flank wear in carbide tools initially occurs due to abrasion and as the wear process progresses, the temperature increases causing diffusion to take

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place. Actually, the fact that abrasive wear may occur in metal cutting is not surprising since there are many hard abrasive particles present in metals, especially in steel. The use of coolant to increase tool life is an issue with many differing views. In contrast, others have found that coolant promotes tool wear in machining. The inherent brittleness of carbides renders them susceptible to severe damage by cracking if sudden loads of thermal gradients are applied to their edge. The better performance of carbides was obtained under dry cutting.

HSS TOOL IMAGE

Fig.1 HSS tools

LITERATURE REVIEW

Several attempts have been made to improve the performance of the cutting tool through different types of coatings by increasing abrasiveness and the hardness.

Stated these coatings offer not only high hardness and excellent refractoriness but also generally lower coefficient of friction, good oxidation resistance and chemical stability. [1]

Efecto del agregado de alumina en la calidad Del recubrimiento de allegation de Zinc Níquel in Congress International dematerialise- CIM – Colombia. Mahmud Z. Paulo T. Gordillo, J. M. N. [2]

Del agregado de particulars ceramics en la composition de la allegation de Zinc Niguel. In XX Congress da Sociedade Iberoamericana de Electroquímica [3]

Astrand M, Selinder TI, Frieze F, Klostermann H, PVDAl2O3-coated cemented carbide cutting tools, Surf Coat Tech. [4]

Stated when cutting ferrous and hard to machine materials such as steels, cast iron and super alloys, softening temperature and the chemical stability of the tool material limits the cutting speed. Therefore, it is necessary for tool materials to possess good high-temperature mechanical properties and sufficient inertness. [5]

Stated the machining of hard and chemically reactive materials at higher speeds is improved by depositing single and multi-layer coatings on conventional tool materials to combine the beneficial properties of ceramics and traditional tool materials. The effect of coatings layer can be summarized as follow. [6]

Observed that cemented carbide can be used for hot application due to their heat resistance and all types of PVD and CVD processes can be used to deposit coatings. The combined substrate-coating properties determine the important properties such as wear, abrasion resistance and adhesion strength of a coating. [7]

Smith stated a hard ware resistant coating cannot perform well unless complimented by a hard and tough substrate. Thus, a hard coating deposited on a soft substrate leads to poor properties reported. [8]

PVD and CVD coatings offer today a powerful alternative to improve further the cutting performance of the cutting materials. Under dry machining with high cutting speeds and high-feed rates, the coating is worn away rapidly which results wear of the carbide substrate. [9]

A question of recent interest is to review whether the resistance of cermet cutting tools to wear has improved by the use of appropriate hard coatings. Research in this area is concentrated on new composite gradient coating, multi component and multilayer coating and adding new elements to coating combination like silicon or vanadium.

Measurement and analysis of surface roughness in turning of aerospace titanium alloy (gr5), Elsevier Journal, Measurement 45 (2012) 1266–1276. [11]

SELECTION OF METHODS AND MATERIALS

Process Methods

- PVD Coating
- CVD Coating

Fig.2 PVD Machine

Coating Materials

- Nickel Coating
- Chromium Coating
- Zinc Coating

Fig.3 Ni-Cr-Zn

WORKING PRINCIPLE

Physical Vapour Deposition - also known as PVD Coating - refers to a variety of thin film deposition techniques where solid metal is vaporized in a high vacuum environment and deposited on electrically conductive materials as a pure metal or alloy coating. As a process that transfers the coating material on a single atom or molecule level, it can provide extremely pure and high performance coatings which for many applications are much preferable to electroplating. PVD Coating processes are environmentally friendly processes that can greatly reduce the amount of toxic substances that must be disposed of with more conventional types of coating that involve fluid precursors and chemical reactions. PVD is fundamentally a vacuum coating technique vaporizing a metal to plasma of atoms or molecules and depositing them on a wide range of substrates. Carried out in a high vacuum chamber approximating outer space at 10-2 to 10-4 milliard, the process usually takes place between 150 and 500 Degrees C. The material to be coated is secured in a fixture and placed in the vacuum deposition equipment chamber. The equipment is pumped down to the optimum pressure depending upon the coating materials, substrate and process used, and the object to be coated is often preheated and sputter cleaned. The carbides, nitrides, silicide's and borides that make up the PVD coating materials each have special qualities tailored to specific applications. Graphite and titanium for example are often used in high performance aerospace and automotive component where friction and temperature are crucial success factors. To achieve a uniform thin film coating thicknesses that are often a few atoms or molecules thick, parts to be coated are often rotated on several axis at a uniform speed, or placed on conveyor belts moving past the deposition material's plasma stream. Single or multi-layered coatings can be applied during the same deposition cycle. A wide variety of types of PVD coatings are available, including Zirconium Nitride (ZrN), Zirconium Carbon Nitride (ZrCN), Titanium Nitride (TiN), Titanium Carbon Nitride (TiCN), Chromium Nitride (CrN), Chromium Carbon Nitride (CrCN), and Chromium Nitride (CrN).

EXPERIMENDAL TESTS

Knoop Hardness Test

The Knoop hardness test is a micro hardness test - a test for mechanical hardness used particularly for very brittle materials or thin sheets, where only a small indentation may be made for testing purpose.

Fig.4 Knoop Hardness Test Machine

Wear Test

When friction is the predominant factor causing deterioration of your materials, abrasion and wear testing will give you data to compare materials or coatings and can help you predict the lifetime of a material or coating. Abrasion testing is used to test the abrasive resistance of solid materials.

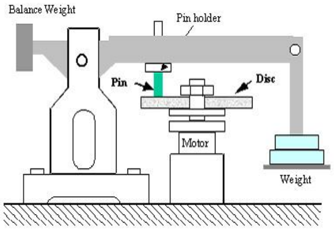


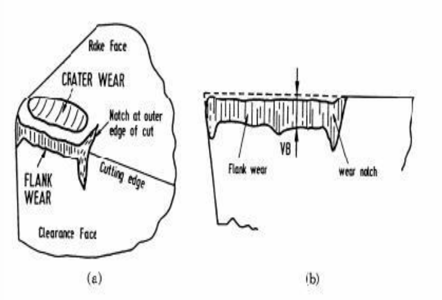
Fig.5 Wear Test

TOOL WEAR METHODOLOGY

Under high temperature, high pressure, high sliding velocity and mechanical or thermal shock in cutting area, cutting tool has normally complex wear appearance, which consists of some basic wear types such as crater wear, flank wear, thermal crack, brittle crack, fatigue crack, insert breakage, plastic deformation and build-up edge. The dominating basic wear types vary with the change of cutting conditions.

Types of wear

- Crater Wear
- Flanck Wear
- Nose Wear
- Edge Wear



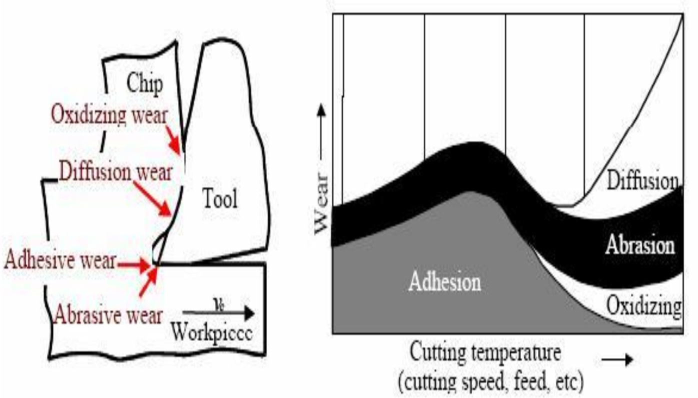


Fig.6 Types of Wear

PHOTOGRAPHS

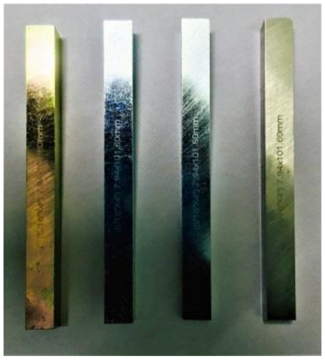


Fig.7 Coated and non-coated HSS tool

TEST REPORTS

Knoop hardness test report

Table 1. Experimental Values of knoop hardness test report

S.No	Materials	Thickness	Value
1	Non coated HSS	-	298
2	Zinc coated HSS	45(µm)	332
3	Chromium coated HSS	65(µm)	324
4	Nickel coated HSS	55(µm)	358

Wear test report

- Work piece material: mild steel
- Plate size: 150×100×10mm

Table 2. Test Parameters of wear test report

S. No	Test parameters	value
1	Normal force	20 N,40 N
2	Wear track length	12mm
3	Speed	200cycles/min
4	Revolution	6000
5	Pin geometry spherical	Ø 6mm
6	Pin material	Al

Table 3. Experimental Values of wear test report

S .No	Materials	Sliding speed(m/s)	Load (N)	Wear rate (mm^3/m)
1	Non coated HSS	2	20	0.0028
		2	40	0.0031
2	Zinc coated HSS	2	20	0.0016
		2	40	0.0018
3	Chromium coated HSS	2	20	0.0019
		2	40	0.0022
4	Nickel coated HSS	2	20	0.0014
		2	40	0.0016

CONCLUSION

In the present work the performance of coated hss tools by using chromiun,zinc and nickel conditions is studied.the results shows that the coated tool perform better as compared to uncoated cutting tool.the effect of cutting is to reduce wear and tear of tool tip point as well as more heat dissipation to surrounding hence the increase in tool life and surface finish of the product to be machined. With increase in depth of cut the surface roughness is increased.here experimental results shows by selecting the proper cutting parameters the coated tools are suitable to produce fine surface finished components.

REFERENCES

[1]. Astrand M, Selinder TI, Fietzke F, Klostermann H, PVDAl2O3-coated cemented carbide cutting tools, Surf Coat Tech, 2004.

[2]. Corduan, N., et al. Wear Mechanisms of New Tool Materials for Ti-6AI-4V High Performance Machining, CIRP Annals – Manufacturing Technology, 2003.

[3]. Different coatings were developed by the author Daniel W. Parker for different applications like turbo machinery, diesel engines for trucks, power plants, marine applications and automobile uses, 1992.

[4]. Grzesik W, Luttervelt CA, Analytical models based on composite layer for computation of tool-chip interface temperatures in machining steels with multilayer coated cutting tools., Ann CIRP Manuf Technol, 2005.

[5]. J.A. Ghani, I.A. Choudhary, H.H. Masjuki, "Wear mechanism of TiN coated carbide and uncoated cermets tools at high cutting speed application" , Journal of Materials Processing Technology, 2004, 1067-1073

[6]. Mahmud, Z. New material comprising a Zn metal matrix and ceramic particles having very good mechanical properties and high corrosionresistance Alumina incorporated steel, in EUROMAT 2013- European Congress and Exhibition on Materials in Sevilla-2013.

[7]. Mahmud Z. Paulo T. Gordillo, J. M. N. Efecto del agregado de partículas cerámicas en la composición de la aleación de Zinc Niquel.In XX Congresso da Sociedade Iberoamericana de Electroquímica, 2012, 2–3.

[8]. S. Ramesh, L. Karunamoorthy, K. Palanikumar, "Measurement and analysis of surface roughness in turning of aerospace titanium alloy (gr5)",Elsevier Journal, Measurement 45, 2012, 1266–1276.