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THE EFFECT OF WEIGHT OXIDE OF TiO_2AGAINST THE FLANK WEARING INSERTS LAYER$TiO_2+Al_2O_3$ON THE DRY LATHING OF THE STAINLESS STEEL AISI 301

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ABSTRACT

Failure of the cutting tools was inevitable and can be experienced by all types of tools. Wearing was a bit defect and had a negative effect on the cutting process. Reduce wear by choosing the tool type to adjust the cutting parameters and the correct cutting conditions. Hardness was considered when choosing the type of cutting tool. Cutting tools that had been proven and tested were quality. Tool inserts of $TiO_2+Al_2O_3$ oxide coatings could increase the hardness of the tool, reducing the heat by friction between the tool and the workpiece to extend the tool's use to the cutting process. In this research, two types of $TiO_2+Al_2O_3$ coated oxide beads were used with a percentage of oxide content 96.95% TiO_2+3.05% $A1_2O_3$ and 98.92% TiO_2+1.08% $A1_2O_3$, for stainless steel AISI 301. Cutting parameters, Vc= 101.4; 119.3; 155.1 m/ min, Vt= 0.18; 0.22; 0.28 mm/ rev, a= 1.5 mm, tc= 30 min and experimental dried conditions. The purpose of this research was to observe the effect of the TiO_2 oxide coating on wear, especially the bit shaft, resulting from the dry result of AISI 301 Stainless Steel. The result showed that the coating properties and the percentage of TiO_2 oxide weight could affect the amount of side wire (VB) of the tool. The maximum axis of flank wear on the weight percent 96.95% TiO_2 of 0.242 mm and 98.92% TiO_2 of 0.225 mm. Cutting parameters, cutting speed, feed rate, depth of cut, cutting time and cutting conditions could affected tool wear, cater wear, flank wear, notch wear and flaking. Built Up Edge (BUE) was visible while cutting the AISI 301 stainless steel.

Keywords: lathe machine, oxide tools insert, cutting parameters, digital microscope, stainless steel AISI 301.

1. INTRODUCTION

Tool wear is still a key issue in the editing process because it is ineffective and reduces product quality. Wear tool is inevitable and will inevitably take place, can only be minimized by proper cutting such as tool selection, parameter determination, process material selection and cutting conditions.

According to [1,2,3] are usually processed to manufacture the outer components made by wet machining method. Liquid media is applied to cut cutting contacts and workpieces during the process to lubricate the machining parts and reduce the cutting temperature so that the machining surface has a smooth surface integrity. The condition is indeed favorable, but on the other hand, if the ex-cutting fluid is deposited in the wild, it will damage the environment; it will certainly cost the cost of production. The right choice to prevent environmental damage and minimize production costs is the dry operation in the industrial world, known as greening. With dry machining, production costs decrease by 16-20% of the total cost of production [4], in addition to the environment.

Oxide tool inserts are widely used in large and small industries because their hardness properties are suitable for cutting materials such as aluminum and steel, which are well known and produce faster components as desired. Tool inserts with Tungsten Carbide (WC) and Cobalt (Co) based materials, consisting of coating and non-coating inserts. The coating layer material such as carbide powder, nitride, and oxide. The coating is aimed at increasing the hardness and wear resistance with low coefficients of friction [5,6]. The liner on the inserts also serves as a solid lubricant to reduce friction and heat generation during the process [7,1]. In addition to the coating to extend the life of the tool obtained by cryogenic treatment, the abrasion resistances of tool [8, 9, 10, 11] are improved. Tool wear is also strongly influenced by cutting style, increased cutting force protection when increasing cutting temperature, the condition cuts tool loss hardness, deterioration is faster so that tool life shorter [12,13].

The priority of processing products is superficial quality. The cutting product is considered qualified if it qualifies as the exact product size or precision in accordance with the demand for work drawings; the level of roughness of the permitted limits or normal The quality of the cutting or machining surface can be seen from the surface enlargement value. The smaller the roughness value, the smoother the surface, the higher the quality, so it's reasonable to say that if the roughness of the cutting or processing surface gets serious attention [14,15,16]. Satisfactory surface conditions are based not only on surface roughness values but also on microstructure, surface hardness, residual stress values and fatigue life. Machining products are almost certainly used in the automotive and aviation industry and are operated under tense and high temperatures, so absolute surface integrity to avoid sudden fatigue failure [15.17].

Surface quality is greatly influenced by tool wear so that the tool's choice must be accurate and adjusted to the material to be processed. Cutting the $TiO_2+Al_2O_3$oxide inserts are tested for wear on the dry cutting process of AISI 301 stainless steel. Stainless steel, including stainless steel austenite category with chemical composition

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0.038% C, 0.299% Si, 1.381% Mn, 0.063P, 0.026% S, 18.100% Cr, 7.347% Ni, 0.018Sn, 69.995% Fe with hardness 174 HB. Stainless steel AISI 301 has the properties of corrosion resistance, fabrication, welding, and presence of Cr resistance to high-temperature oxidation. Stainless steel in the field of automotive and aerospace industries is as same as shaft elements, valves, fittings, and springs.

2. RESEARCH METHODS

a) Tools and test materials

The lathe used the CM 6241 x 1000/ 1500 mm mark, type of insertion 2 coated (TiO_2+Al_2O_3). Characterization of the tool was tested with Energy Dispersive Spectroscopy (EDS), the weight of oxide respectively (3.05% Al_2O_3+96.95% TiO_2) and (1.08% Al_2O_3+98.92% TiO_2). Hardness Tool was tested Rockwell C hardness, 79.74 HRC for tool 96, 95% TiO2 and 87,52 HRC for Tool 98.92% TiO2. The built-in sculpture geometry is triangular in shape with 60^0 cut corners. Toolholder MR (Marox) Type PTGNR 2020K16. Material process Stainless steel AISI 301 size Ø38 x 350 mm. Wear Tool is measured using Microscope Digital, HD Color CMOS, HS Dsp, 24 bit DSP, OR 2592x1944, 50x DZ. Cutting parameters, as shown in Table-1:

Table-1. Cutting tools parameter.

Factors	Level 1			Level 2			Level 3		
Cutting speed (Vc) m/min	101,4			119,3			155,1		
Feed rate (V_f) mm/ rev	0,18	0,22	0,28	0,18	0,22	0,28	0,18	0,22	0,28
Depth of cut (a) mm	1,5			1,5			1,5		
Cutting time (tc) min	30			30			30		
Cutting condition	Dry								

b) Tests and measurements

a) Make a flashlight on the workpiece to pinch the workpiece between the head stock dan tool post.

b) Place the workpiece between the headstock and the tail stock of the lathe and set the cutting parameters (Vc, Vf and a).

c) Attach the tool (tool insert + holder) on the platform

d) Adjust the cutting edge height with a flashlight (the cutting edge position islocated directly on the center axis of the workpiece).

e) Turn on lathe and do the cutting process.

f) Data retrieval is done after 30 minutes of cutting process

g) Stop the cutting process and turn off the engine.

h) After each cutting procedure has been completed within 30 minutes, complete the measurement tool wear with the digital microscope, then record the measurement results.

i) Change the cutting parameter variables in the order shown, turn on the machine with the cutting process and measure according to the predetermined variable (Table-1).

3. RESULTS AND DISCUSSIONS

A. Results

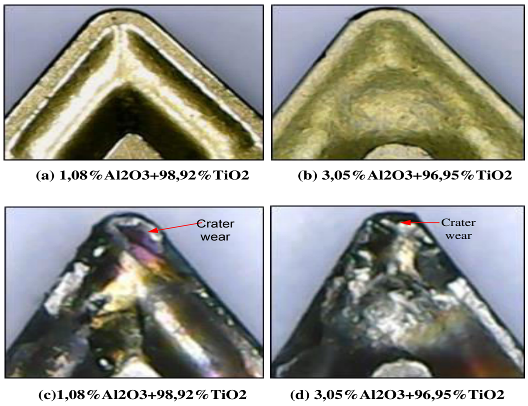

Figure-1. Tools profile: a), b) Before used; c), d) After used.

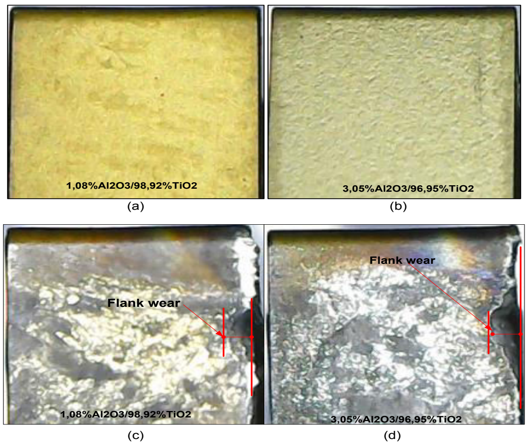

Figure-2. Tools profile: a), b) Before used; c), d) After used.

Figure-3. Notch wear.

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Figure-4. Flaking.

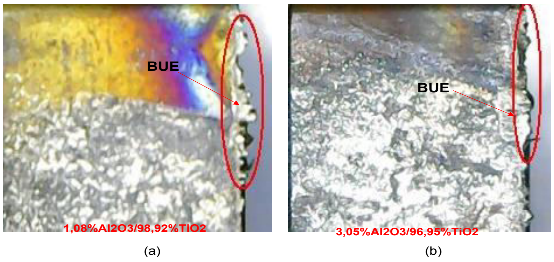

Figure-5. Built-Up Edge (BUE):
a) (1, 08% Al2O3+98, 92% TiO2); b) (3, 05% Al2O3+96, 95% TiO2)

B.DISCUSSIONS

Figure (1 to 5) indicates the variety of insertion failures that are coated with $TiO_{2+}A1_2O_3$ oxide, after cutting the stainless AISI 301 steel for 30 minutes. Figure-1 shows the failure of both types of tool in the form of crater wear, this wear occurs due to the action of snarl or flake that flows along the rake face. Wear crater starts when the cutting speed increases causing the cutting temperature increases also especially on the contact area between the fist and the sculpting surfaces that keep rubbing so that under certain conditions chemical dissolution occurs and there is erosion by furious against the rake face tool. This condition, takes place at cutting tool (Vc) 101.4 - 155.1 m/min, feed rate (Vf) 0.18 - 0.28 mm/rev and depth of cut (a) 1.5 mm in cutting times (tc) 30 minutes.

Figure-2 shows the flank wear experienced by each tool, this wear occurs in the main/major field of the tool, due to the shape of the end of the cutting edge radius by the friction between the cutting surface of the work piece and the tool side due to the rigidity of the work piece. Flank wear is increasing with the increase of cutting tool (Vc) 101,4 - 155,1 m/min, feed rate (Vf) 0,18 - 0,28 mm/ rev, at depth of cut (a) 1,5 mm. This is due to the increase of pressure, friction, cutting force and cutting temperature, especially contact between the tool and the work piece, between the tool and the chip. When the cutting temperature increases, all energy is converted into heat energy that propagates into the work piece, cutting tool and chips, so that the heat flowing in the cutting tool changes the behavior of cutting tool that is the decrease of hardness of tool then there is erosion on the main/major field tool by chip as well as the molecular breakdown process or the bonding of atoms on the tool shear plan. Flank wear (VB) min for tool layered (1.08% $A1_2O_3$+98.92% TiO2) of 0.108 mm at Vc = 101.4 m/min, f = 0.18 mm / rev, a = 1.5 mm, tc= 30 min and VBmax of 0.225 mm at Vc = 155.1 m / min, f = 0.28 mm/rev, a= 1.5 mm and tc= 30 min. While tool layered (3.05% $A1_2O_3$+96, 95% TiO_2) at the same condition VB min = 0,114 mm and VB maks = 0,242 mm. The magnitude of flank wear indicates that the weight of $A1_2O_3+TiO_2$ oxide can affect tool performance or extend tool life. This is reinforced by; [1,8], that the coating on the tool can serve as a solid lubricant can also reduce heat due to friction during the cutting process. The combination of the oxide layers TiO_2 and Al_2O_3 are united in strong bonds and have strong properties as abrasives, oxidation shields, have high thermal conductivity and also high temperature resistance with melting point of 1843^0C and 2072^0C respectively. With properties of $TiO_2+A1_2O_3$ oxide layer, it is very suitable to be used as a cutting tool coating especially cutting tool.

Figure-3 shows failure of a tool in the form of wear, similar to the flank wear that occurs when cutting steel or aluminum. Due to the properties of austenitic stainless steels, including hard materials and abrasives, wear often occurs when cutting tools. Also due to the increase of the cutting tool and the feed rate, the tool gets a higher pressure load causing the wear. This wear occurs in the contact area between the workpiece and the tool.

Figure-4 shows the variety of fragile fracture errors. Peeling or peeling of the tool coating material results from an attractive force between the carbide tool (WC-Co) substrate and the $TiO_2+Al_2O_3$ oxide coating material by heat in the contact area. Another factor, since the tool installation is not rigid due to inconsistent cutting pressure, girls can curl. Intercepting intersections may also be the cause of tool or broken fragile fragments.

Figure-5 shows the formation of the Built UpEdge (BUE) during the cutting process, the wear mechanism caused by the adhesive force. This adhesion style will result in the accumulation of brewing in the cutting eye, which occurs around the main plane and the field of anger. As a result of increasing parameters, causing relatively high pressure and temperature on the surface of the newly formed metal to retain with other metal surfaces after the first oxidation process. Built Up Edge (BUE) will change the geometry of the tool as it serves as the new cut eye of the tool in question. BUE is a dynamic structure, because during the BUE cutting process it grows and at some point the upper layer or entire BUE will peel off. Observations during the BUE intersections are formed at a cutting speed (Vc) of 101.4 - 155.1 m/min which gradually increases and disappears when the cutting process occurs. The Built Up Edge (BUE) Growth and Shrinking process occurs regularly so that the cutting tool eye goes out quickly and at some point the tip of the tool is no longer strong to withstand the growing cutting force, leading to fatal damage. For low speed cutting without shock, BUE will be more stable, because peeling occur only the top of the BUE, so that the tool surface is protected. In addition to the formation of BUE surface quality of the material in the process of decreasing or rough.

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4. CONCLUSIONS

a) The coating properties and the weight percentage of TiO_2 oxide can affect the flank wear (VB),flank wear size, the maximum cutting edge of each tool in weight percent 96.95% TiO_2 with 0.242 mm and 98.92% TiO_2 by 0.225 mm.

b) Cutting parameters, cutting speed, feed rate, depth of cut, cutting time and cutting conditions can affect tool wear, crater wear, flank wear, notch wear and flaking.

c) Built Up Edge (BUE) is visible while cutting the AISI 301 stainless steel process.

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