AN EXPERIMENTAL INVESTIGATION OF UNCOATED WC-Co TOOL LIFE AND WEAR IN TURNING OF STAINLESS STEEL

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ABSTRACT

Stainless steel is one of the most popularly engineering materials with wide variety of applications. Stainless steel is iron-base alloys containing 10.5 percent or more chromium, which acts as inhibitor from getting corroded. In addition, stainless steel is known as high ductility and weldability material. However, stainless steel is having low machinability due high built-up edge (BUE) formation, high work hardening and low heat conductivity which consequently contributed to poor surface quality and rapid tool wear. In the present work, the machinability of stainless steel is studied using uncoated WC-Co cutting tool in turning process. Three levels of rotational speed (N) with constant feed rate (f) and depth of cut (d) were investigated toward tool wear, tool life and surface roughness. The wear mechanism will be examining using Scanning Electron Microscope (SEM) while the tool life calculated based on V_B length. The surface roughness was measured by Portable Surface Roughness Machine. The result showed that the tool wear is increased with the increasing of speed. Similarly, the tool life decreased as the cutting speed increased. The surface roughness is decreased as the cutting speed increased. Flank wear and crater wear are main wear mechanisms in this experiment. Flank wear is mainly occurred on the flank side that attributed to the rubbing action of edge tool along the machined work piece. Meanwhile, the crater wear was observed on the rake face due to diffusion wear mechanism. These results shown that the cutting speed in machining is mainly impacts the surface finish and tool wear.

Chapter 1

INTRODUCTION

1.1 Background of Study

The selection of cutting tool materials is the most important factor in the machining operations. The selection of cutting tool materials should consider certain criteria such as high temperatures, high contact stresses and rubbing along the tool-chip interface and machine surface.

A cutting tool is any tool that is used to remove material from the work piece by means of shear deformation. The cutting tool consists of single-point or multipoint tools.

Single-points tools are used in turning, shaping, planning and similar operations. Cutting tools have to resist high temperature and overcome temperature gradients, thermal shock, abrasion, attrition, and chemical induced wear. So the materials used for cutting tools must have a high hardness and strength to overcome high heat which causes the interrupted cuts or vibrations during the machining process.

A cutting tool must possess the following characteristics in order to produce good quality. The first characteristic is hot hardness where the cutting tool should maintain its hardness, strength and wear resistance at a high temperature in the machining operations. This property ensures that the tool does not undergo any plastic deformation thus retains its shape and sharpness. Furthermore, the cutting tools should resist the impact of forces due to vibration and chatter without chipping or fracture. The thermal shock resistance also needs to be possessed to overcome the rapid temperature cycling encountered in the interrupted cutting.

Tungsten carbide has been well famous cutting tool for the best performance, high hardness, and strength and wears resistance. Tungsten carbide (WC) typically consists of tungsten-carbide particles bonded together in a cobalt matrix. The amount of cobalt acts as improver toughness so the brittle fracture can be avoided. Tungsten carbide particles combine with the cobalt in a mixer, resulting in a composite material with a cobalt matrix surrounding the carbide particles. The toughness of WC increases as the high toughness of cobalt while the wear resistance WC decreases as the carbon content increases[1].

Meanwhile the work piece need to be machining is 316L stainless steel. It serves a multitude of applications from brightly polished consumer products to machinery and equipment for the tough industrial environment. Stainless steel consists of iron base alloys and chromium. Chromium is alloying element that impact to stainless steels their corrosion-resistant qualities that act improver film stability, molybdenum and chromium also increase resistance to chloride penetration[2]. It is involved in the hard machining process due to the high tensile strength and ductility. This hard machining is decreasing the manufacturing's cost and improving the machine utilization. However, the poor machinability of the stainless steel is resulted from having a very low heat conductivity, high fracture toughness and work hardening rate.

Among the austenitic stainless steel, AISI 316L has good mechanical properties because it contains low carbon and has a very high immunity from grain boundary carbide precipitation[3]. The industry predominantly uses 316L stainless steels in the oil and gas and chemical industries. Meanwhile, for the typical applications are:

- heat exchangers
- condensers
- medical implants
- Semiconductors
- Control lines
- Process engineering

These applications are due to its cost effective corrosion resistance and ease of fabrication. In addition, the austenitic structure provides excellent toughness. The 316L stainless steel also provides higher creep, stress to rupture and tensile strength at elevated temperatures.