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Analyze the Performance Evaluation between Oil Based Coolant and Environmentally Based Coolant on Cutting Surface in Milling Operation

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By

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ABSTRACT

In this paperwork will represent the performance analysis of cutting fluid during milling machine. The analysis is concentrate more on the effect to the milling work surface. Generally, there have a few type of cutting fluid and the application of cutting fluid to the machining process will give a few advantages such as producing a good surface finish. Therefore, the main purpose in this experiment is to investigate the performance of cutting fluid that used up to the work piece during milling process and to define the best type of cutting fluid that can be used to produce a good surface roughness. The experiment is using a carbon steel AISI 1045 as a raw material with dimension of 100 x 100 x 50. The work piece is be milled by conventional milling machine with two different type of cutting fluid which is Soluble cutting oil and Bacteriostatic Imulsifiable cutting oil. The parameters setting such as cutting speed is set differently, 100rpm, 200 rpm, 300 rpm and 400rpm. The feed rate is 1 mm/rev and depth of cut with 0.5 mm will remain constant. Surface Roughness value is taken through surface roughness tester and morphology inspection was done using metallurgy microscope. As the result, the bacteriostatic imulsifiable cutting oil produces a better surface roughness rather than soluble cutting oil. A few factor is identified that can affect the surface roughness value such as cutting speed and machining time.

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CHAPTER 1.0

INTRODUCTION

1.1 Introduction

Cutting fluid in which also known as coolants or lubricants play an important role in material removal process and machining operation such as drilling, turning and milling. Traditionally, coolants have been used a long time ago, a study was reported that it help to achieved 40% increase in cutting speed while machining steel with high speed steel tool and water as coolant [Taylor, 1907]

During the process, this lubricant may be considered as an accessory which is frequently applied in order to increase production rate, improve surface qualities, reduce costs and consequently increase profit [J. M. Vieira, 2001]. The fluid or heat transfer fluid will flows through a work piece and cutting tool to reduce the friction thus avoid from overheating, transferring the heat produced or dissipate it. Besides that, the fluid will wash away the chips and reduce the occurrence of built-up edge on working surface.

There are two categories of cutting fluids which is water based and oil based [P. Runge, 1997]. For water based, the cutting fluid are mainly produce by combination of cooling and lubricants properties and the most common type that being used for machining process is oils and emulsions. While for oil based, the properties are basically made of pure oil which will contribute to good lubricating requirement. In this category, there also have two types in common which are semi-synthetics and synthetics. Each type of the cutting fluid will consist of different properties and characteristic.

Furthermore, its effectiveness in cutting operation depends on a number of factors such as the method used to apply the cutting fluid, temperatures encountered, cutting speed and type of machining process [Serope Kalpakjian, 2001]. The methods used for cutting fluid can be divided into three applications which are flood cooling, mist cooling and high pressure system. Each method will produce a differ range of air pressure and cause a different result.

However, the usage of cutting fluid can also cause problem in a few cases. In which, the prolonged contact of machines operator with cutting fluids may cause skin and respiratory diseases [Y. Su, 2005]. The cutting fluid may also cause defects if the material is not suitable such as machining with ceramics tools, particularly alumina based ceramics, with inadequate fracture toughness may not tolerate the application of cutting fluid [J. M. Vieira, 2001], the heated zone in the tool promoted by the cutting action will experience thermal shocks in presence of cutting fluids which this often leads to severe cracks or even fracture of the entire tool edge. Furthermore, with inappropriate clearance of cutting fluids it may cause pollution in ground, water and environment. Hence, many new technology of cutting fluid are invented to prevent the weakness and produce with more cooling and lubricant characteristic.

1.2 Objective

1. To investigate the performance between Soluble Cutting Oil and Bacteriostatic Emulsifiable Cutting Oil
2. To define the most suitable type coolant that can be used to produce good surface roughness.
3. To determine the best cutting fluid for machine shop operation.

1.3 Scope of Project

The scope of this project is to analysis the performance of cutting fluid during milling. The study will be focused more on the effect of the working surface. The process used a face milling and will be carrying out using two different type of cutting fluid. The material to be milled is carbon steel AISI 1045 and the process will be done with different cutting speed and uniformly with different type of cutting fluid. The types of cutting fluids are soluble cutting oil and bacteriostatic emulsifiable cutting oil. Each of the samples will be analyzed using surface roughness tester and metallurgy microscope. Then, from the result, comparison of the surface roughness between those two types of cutting fluid will be discussed and the most suitable cutting fluid will be identified.

1.4 Problem Statement

Cutting fluid has been widely used in machining process. From the time when first discovery of the usage of cutting fluid, it is believe that this additional application can maximize the cutting tool life and produce a better surface roughness. Due to those advantages, it will automatically increase the production rate, reduce the cost of raw material and consequently increase profit by saving budget.

Nowadays, there are lots of cutting fluid available in markets, which were created with different properties and characteristics. In additional, since the laboratory of manufacturing faculty has offer the course of using the milling machine, then it will be an advantage to do the study so the outcome can be suggested to the laboratory management. Generally, with unsuitable cutting fluid, it will produce a high costing in changing the lubricant and yet many points of view need to be identified. Besides, the performance from the current cutting fluid is also not clearly applicable whether it is satisfactory or not to the surface finish.

Therefore, this study hopes to improve the usage of coolant and determine the best one that can be used in milling process.

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CHAPTER 2.0

LITERATURE REVIEW

2.1 Actions of Cutting Fluids

Basically, cutting fluid has a relationship with the heat. There have several effect of cutting fluids on heat transfer and generally classified as:

- Cutting fluids may reduce the cutting force such as friction, therefore heat generation is reduced to some extent.
- Using cutting fluids, heat generated in machining can be rapidly removed away by convection.

Traditionally, there have several purposes on using the cutting fluid on machining process. Even though there have some operations where they are performed dry, it produces a different result whether for working surfaces or the cutting tool. The cutting fluid fulfills basically three major functions which is lubrication, cooling and chip removal.

2.1.1 Lubrication

Access of the fluid to the rake face is difficult, especially at higher cutting speeds. The fluid does, however enter the sliding zone, and some fluid may seep in from the side of the chips too. Effects attributable to lubrication can be frequently observed, especially when contact with the cutting tool is intermittent. In low-speed cutting with sliding friction, rake face friction is reduced, therefore the shear angle increases, the chips become thinner and curls more tightly, and power consumption drops. At all speeds, lubricant access to the flank face is possible and rubbing is reduced. The combined effect is that, in general, surface finish is also improved.

2.1.2 Cooling

Because shear is highly concentrated and the zones moves extreme rapidly, temperatures in the shear zone are not affected. However, a cutting fluid reduces temperatures of the chip as it leaves the secondary shear zone, and it cools the work piece. It may also reduce the bulk temperature of the tool. While relationships are by no means straightforward, it is often found that a cutting fluid reduces temperatures sufficiently to allow cutting at higher speeds. In the majority of instances it is, however, essential that the fluid be applied to the cutting zone. In interrupted cuts, such as milling, the tools are subjected to rapid temperature fluctuations. A coolant is helpful only if it floods the entire cutting zone; otherwise, it subjects the tool to more extreme temperature fluctuations.

2.1.3 Chip Removal

Cutting fluids fulfill an additional and sometimes extremely important function. They flush away chips from the cutting zone and prevent clogging or binding of the tool. Chips are the transported away by conveyors or vacuum.

2.2 Method of Cutting Fluids

The method of applying cutting fluid is as important as is their selection. They are manual application and treatment of lubricants and chips.

2.2.1 Manual Application

The application of a fluid form a squirt can or in the form of a paste (for low speed operations) is commonly practiced even though it is not really acceptable even in job-shop situations. In the absence of cooling, cutting speeds are limited, and it is difficult to keep the machines and plant clean

a) Flooding

Most machine tools are equipped with a recirculating system that incorporates filters. The fluid is applied at a rate of up to L/min for each simultaneously engaged cutting edge. For convenience, the tool is usually flooded from the chip side, although better cooling is secured by application into the clearance crevice, especially when the fluid is supplied under a pressure of 300kPa (40 psi) or more. High pressure system apply pressures of 5-35 MPa (0.8-5 Kpsi) and, hitting at 350-500 km/h, help to carry away chips, but the entire workspace must be enclosed. A second nozzle may be necessary to clear away the chips in some operations.

b) Coolant-fed Tooling

There are drills and other tools available in which holes are provided through the body of the tool so that the pressurized fluid can be pumped to the cutting edges, ensuring access of fluid and facilitating chip removal. For inserts, coolant nozzles may be built directly into tool holders, and some inserts have holes through which coolant is delivered to the underside of the chip.

c) Mist Application

Fluid droplets suspended in air provide effective cooling by evaporation of the fluid, although separate flood cooling of the work piece may be required. Measures must be taken to limit airborne mist, for example, by the use of demisters.

2.2.2 Treatment of Lubricants and Chips

Recirculation systems may be small for individual machine tools or very large, integrated installations for an entire plant. In either case, lubricant quality must be carefully monitored and appropriate makeup of oil or water made. Because disposal is becoming increasingly difficult and costly, fluids are selected that are more readily recycled. In some processes, such as milling and gear hobbing with carbide cutters, dry machining is also growing. Chips kept carefully segregated and deoiled in a centrifuge can be returned for recycling.

2.3 Coolant / Metalworking Fluid Types

Coolant is categorized into four main groups, and each group is available in many different formulations. The following are the coolant categories and the amount of oil present in their formulation:

Table 2.1: Categories of Cutting Fluid

Type of Coolant	Properties
Oil Soluble	Contains 60-85% mineral oil and emulsifies into water
Semi-Synthetic	Contains 5-50% mineral oil and emulsifies into water
Full Synthetic	Contains no mineral oil
Straight Oils	Contains 70-85% mineral oil and is not water-miscible

A soluble oil based coolant works relatively well over a broad range of operations, but has lower tramp oil rejection properties then that of a semi-synthetic. A full synthetic has great tramp oil rejection properties but can lead to rust on machine interiors. Straight oils are primarily used in drilling and tapping operations, but are the most stable and easiest to maintain overall since they contain no water.

2.4 Temperature

The energy expended in machining is concentrated in a very small zone. Only a small fraction of it is stored in work piece and chip in the form of increased dislocation density and the vast majority of energy is converted into heat.

The cutting temperature is varies depending on types of material and the cutting speed employed and the rate of metal removal. The greatest heat generated when the ductile material of high tensile strength such as steel is cut (Kalpakjian and Schmid S.R, 2001).The lower heat is generated when soft material of low tensile strength such as aluminum is cut. The maximum temperature created during the cutting action will affect