MONITORING DETERIORATION AND LUBRICITY OF CUTTING FLUID

MAHSHURI YUSOF

Universiti Malaysia Sarawak
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Alamat tetap: Kampung Tian Matu,
96250 Matu, Sarikei,
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This project report entitled "Monitoring Deterioration and Lubricity of Cutting Fluid" was prepared by Mahshuri Yusof as a partial fulfillment for the Bachelor of Engineering (Hons.) Mechanical Engineering and Manufacturing System degree programme is hereby read and approved by:

____

Dr. Ha How Ung

(Project Supervisor)

Date: 13/5/99

Monitoring Deterioration and Lubricity of Cutting Fluid

by

Mahshuri Yusof

This report is submitted in partial fulfillment of the requirement for the degree of

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Thank you Allah…for giving me strength to finish this project.

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TABLES OF CONTENTS

CONTENT	PAGE

LIST OF TABLES

LIST OF FIGURES

ABSTARCT

This research describes the monitoring of the deterioration and lubricity of cutting fluid and subsequently derives several relationships in order to determine the objectives of the research.

There were two objectives of this research: to determine the rate of deterioration of the cutting fluid and to determine the relation between the level of contamination and lubrication behavior. To achieve these objectives, lab experiment was carried out. It involved the design ad construction of a simple lubricity test rig. The amounts of the debris in the cutting fluid were determined and result was analyzed. The coefficient of friction was measured every time the sample of cutting fluid was taken. The relationship between coefficient of friction and time and the amount of wear particles and time were determined. From both relationships, we can determine the relationship between the amount of wear debris in the cutting fluid and the coefficient of friction.

ABSTRAK

Kajian ini membincangkan tentang pemerhatian terhadap kehadiran partikel-partikel asing dan kelinciran "cutting fluid' dan seterusnya mentakrifkan beberapa hubungan bertujuan untuk mencapai objektif kajian ini. Kajian ini meliputi dua objektif iaitu untuk mengetahui kadar kehadiran partikel-partikel asing dalam "cutting fluid" dan untuk mengetahui hubungan antara tahap kandungan partikel-partikel tersebut dengan kelinciran "cutting fluid". Untuk mencapai objektif tersebut, satu eksperimen hendaklah dijalankan. Ia melibatkan proses mereka dan mendirikan "simple lubricity test rig". Jumlah partikel di dalam "cutting fluid" diperolehi dan keputusannya dianalisis. Nilai pemalar geseran diambil setiap kali sampel diambil. Hubungan antara pemalar geseran-masa dan kandungan partikel asing di dalam "cutting fluid"-masa diperolehi. Dengan itu, hubungan antara pemalar geseran dan kandungan partikel di dalam "cutting fluid" dapat diketahui.

CHAPTER I

INTRODUCTION

1.1 General

For as long as people have been cutting metal, fluid has been used to aid the process. The first fluid that may have been used is water. After that fluids such as animal fats, vegetable oils, mineral oil, oil-in-water emulsion and other synthetic chemical solutions are used. At present, many kinds of cutting fluids have been used. It has become one of the most important components in manufacturing process.

Ever since water was introduced as an integral component of metal working fluid, microbial growth in these fluids has become a major problem. Beside that, other problems such as corrosion of tool and workpiece, loss of lubricity, rancid odors, slime formation, and the plugging of delivery lines also occurred. These problems did not only effected machine but also the human health especially workers who have work with cutting fluid.

Cutting fluid act as the coolant and lubricant between the cutting tool and workpiece. Generally it acts as a good coolant when the speed of cutting process is increase. But the increment of speed would result in an increase in temperature. As a result, the lubricity of the cutting fluid is reduced. There are many other factors, which may also contribute to the reduction in lubricity such as temperature, viscosity, sliding speed, time of sliding, etc. Beside these, the amounts of debris content in the lubricant also effects the lubricity to a certain extends.

This could be just a small problem for small and medium companies but for big company it can be a huge problem. In 1979, maintenance cost was estimated to be over 200 billion U.S dollars in North America and that figure was increased to a half-trillion U.S dollars in 1990's (3). Even more astounding is that, approximately one-third of this expenditure was found to be unnecessary. There were many reasons that could contribute to equipment failures such as operator errors, faulty repairs, lack of training, etc. It is generally accepted within the lubrication community that over 60% of all mechanical failures relate directly to poor or improper lubrication practices.

The objectives of this project include:

i) Determine the rate of deterioration of the cutting fluid.

ii) Determine the relation between the level of contamination and lubrication behavior.

To obtain these objectives, lab experiment will be carried out properly. It involved the design and construction of a simple lubricity test rig. The amount of debris in the cutting fluid will be determined and the results analysed. The experiment will be explained in chapter 4.

1.2 Project Objectives

The project objectives were to determine the rate of deterioration of the cutting fluid and the relation between the level of contamination and lubrication behaviors.

1.2.1 Determine the rate of deterioration of the cutting fluid

Normally the contaminants of the cutting fluid or oil are wear particles or debris. Other contaminants are dust from atmosphere and foreign particles that enter the system due to the leakage of the system but the amount of these are small compare to the wear particles. Contaminants that are present in the lubricant can influence the performance of the lubricant. The oil would not perform very well. That is why the rate of deterioration has to be determined. As the wear rate is known, the maintenance personnel can estimate the time they have to change the oil and do some maintenance activity.

1.2.2 Determine the relation between the level of contamination and lubrication behavior

The amount of contaminant would effect the lubrication behavior. In this project the lubricity is referred in term of coefficient of friction. Coefficient of friction is defined as the amount of frictional resistance to motion. The amount of particles will be measured. Hence, the relationship between the lubrication behavior and level of contamination would be achieved.

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CHAPTER 2

CUTTING FLUID

2.1 General

Cutting fluids are also called coolants and lubricants. Researchers coined the term coolant soon after F.W. Taylor (8) reported that tool life could be improved by applying water. The term lubricant originated with the introduction using oils. A cutting fluid can interchangeably be a coolant and lubricant. The role of a cutting fluid as a coolant or lubricant is very sensitive to the cutting speed. At high-speed cutting operation, the cooling characteristic of coolant is more important than the role of lubrication. At low-speed cutting operations, however lubricity is more important. In this situation, cutting fluid function is to reduce the formation of Build-up edge (BUE) and improves surface finish. The general recommendations for cutting fluids for machining are stated in the table 2.1.

Material	**Type of fluid**
Aluminum	D, MO, E, MO + FO, CSN
Beryllium	MO, E, CSN
Copper	D, E, CSN, MO + FO
Magnesium	D, MO, MO + FO
Nickel	MO, E, CSN
Refractory	MO, E, EP
Steels (Carbon and low alloy)	D, MO, E, CSN
Titanium	CSN, EP, MO
Zinc	D, MO, E, CSN
Zirconium	D, E, CSN

Table 2.1: General Recommendations for Cutting Fluids for Machining

CSN, Chemicals and Synthetics

D, Dry

E, Emulsion

EP, Extreme Pressure

FO, fatty Oil

MO, Mineral Oil

2.2 Function of Cutting Fluid

Cutting fluids are used in metal machining for a variety of reasons. Generally the primary functions of cutting fluid in machining are as stated below:

(i) Lubricating the cutting process primarily at low cutting speeds

(ii) Cooling the workpiece primarily at high cutting speed

(iii) Flushing chips away from the cutting zone.

The secondary functions include:

(i) Corrosion protection of the machined surface.

(ii) Enabling part handling by cooling the hot surface

2.2.1 Cutting fluid as a coolant

In order to increase metal removal rate, feeds and speeds must be increased. The increasing of feeds and speeds cause the increase of temperature. The temperature has to be reduced because it will increase the life of the cutting tool since the hardness is retained. Beside that it will allows the machining process to be performance at a higher cutting speed. The cutting fluid will carry the heat away and as the result the temperature will be decreased. The reduction of temperature of the workpiece reduces thermal distortion and provides better dimensional control and surface finish.

Generally about 75% of the total heat generated in machining are due to the heat of deformation and 25% is due to the friction. About 80% of the total heat produced goes into chip, 10% into tool and another 10% into workpiece. What happen here is small chips that are produced will carry the heat away via a coolant. For a typical shear angle between the base of the chip and workpiece approximately 60% of heat is generated in the shear plane. As the shear angle is increased, the heat generated in the shear plane will decrease since the plastic flow of the metal occurs over a shorter distance. The rest of the heat is produced in the friction plane between the chip and the cutting tool, approximately 30% and in the surface plane between the cutting tool and the newly machined surface, approximately 10%. The shear angle can be increased by reducing the friction at the tool-chip interface with a cutting fluid and by selecting the proper tool geometry. (9)

2.2.2 Cutting fluid as a lubricant

Cutting fluid that acts as a lubricant will reduce the coefficient of friction between the cutting tool and the chips, and between the cutting tool and the workpiece. Lubricant is any substance interposed between two surfaces in relative motion for the purpose of reducing the friction and/or the wear between them. The fluid provides a layer of lubricant to act as a cushion between the workpiece, minimizes adhesion and interactions of one surface with the other. By reducing friction and wear, tool life and surface finish are improved. Improved surface finish is accomplished by retaining the formation of a built-up-edge (BUE) on the cutting tool. A lubricant reduces the BUE by producing a thinner, less deformed, and cooler chip.

2.2.3 Wash the chips away from the cutting region

The fluid will prevent metal pick-up on the both the tool and the workpiece by flushing away the chips as they are produced. If the chips are not removed from the surfaces, the surface finish of the workpiece is not as good as desired.

2.2.4 Provide protection against environmental corrosion

Some coolant has additives that will provide a protective coating. Antioxidants additive prevent oxygen from attacking the cutting fluid. The film will protect the cutting tool from corrosion.