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CUTTING FLUIDS MANAGEMENT

Eva KUCHÁRIKOVÁ, Jozef PETERKA

Abstract

This article is a summary of basic cutting fluid characteristics and discusses how to prevent pollution from them. It includes information about cutting fluids management that can be readily adopted to prevent the onset of fluid degradation, maintain fluid quality, extend fluid service life, and reduce waste. In conclusion the proposal and targets of continual measuring fluid parameters are presented.

Key words

cutting fluids, environment, management, continual measuring.

Introduction

Machining can be defined as the process of removing material from a workpiece in the form of chips. This process is performed in the system MTWJ (M - machine, T- tool, W- workpiece, J – jig). The cutting fluids are integral parts of this system. In general, the cutting medium can be divided into these categories [2]:

- gaseous,
- liquid,
- solid.

Besides the usual tribological requirements, new cutting fluids have to meet the requirements of the environment protection set either by in-house regulations, or regulations imposed by the state or international ISO 14000 standards [9].

In most cases environmental parameters of the cutting fluids are setting new constraints on machinability parameters. Therefore, manufacturers as well as end users should end it in their common interest to develop new kinds of cutting fluids whose quality is identifiable in terms of machinability parameters as well as environmental parameters [8].

Eva Kucháriková, MSc. Eng., Jozef Peterka, Professor, PhD. - Institute of Production Technologies, Department of Manufacturing and Assembly, Faculty of Materials Science and Technology, Slovak University of Technology, Paulínska 16, 917 24 Trnava, Slovak Republic, jozef.peterka@stuba.sk, eva.kucharikova@stuba.sk

Cutting fluid characteristics

The prime functions of cutting fluid are effective cooling and lubrication. With supply of cutting fluids the friction is also reduced. This functions and effects require the cutting fluids to be in a fluid form [1].

There are also consistent media such as fats or powder lubricants. Though the friction can be reduced, they are not able to sink the heat in the cutting area and that is the reason why they are not used so frequently. The main application fields for these lubricates are thread cutting or special forming operations [4].

Only the gas media have not been employed in manufacturing so far because their application is difficult. If particular gases are applied properly, they can remove the heat and also reduce the friction if their chemical properties are suitable [10].

Nowadays the air-mist cooling is also expanding but the cutting fluids are still the most applicable cooling medium by metal machining. Besides cooling and lubrication effects they also have other functions [4].

Main functions of cutting fluid are [1, 7]:

- cooling,
- lubrication,
- removing chips and metal fines from the tool/workpiece interface,
- flushing,
- prevention of corrosion.

Cutting fluids are used in machine shops to improve the life and function of cutting tools. They are also a key factor in the machine shop productivity and the production of quality machined parts.

Currently new requirements can be identified in the metal cutting application field. The attention is mainly concentrated on improving of working conditions, reducing the health danger for machine operators, and application of new manufacturing procedures, materials and technologies. That concludes the necessity for reduction of fat consumption, processes fluids, and their negative influence on the environment [6].

In practice trends of employing new non-ferrous materials and ceramic compositions can be observed. They progressively substitute some metal parts of machines. Working properties of cutting fluids improve. They are able to cover a wide area of requirements for heavy machining operations, which result from production and application of modern metal cutting machines.

There are now several types of cutting fluids on the market, the most common of which can be broadly categorized as cutting oils or water-miscible fluids. Water-miscible fluids, including soluble oils, synthetics, and semi-synthetics, are now used in approximately 80 to 90 per cent of all applications [12].

Although straight cutting oils are less popular than they were in the past, they are still the fluid of choice for certain metal-working applications.

Cutting fluids can be divided into two categories [3, 9]:

- **water-based fluids** -including straight oils and soluble oils,
- **oil-based fluids** -including synthetics and semi-synthetics.

Cutting fluid management for pollution prevention

In the past, it was common for the machine shops to dispose of their metalworking fluids as soon as they showed signs of degradation and decreased performance. This practice resulted from fewer environmental regulations in place at the time [10].

Effective programs can keep metal-working fluid as clean as the initial raw product, significantly prolonging its service life. Facilities may represent a savings of 15 to 50 per cent by implementing a thorough fluid management program. The payback for establishing a management program is often achieved within one or two years.

Castrol company offers manufacturers an easy-to-use and reliable way of achieving consistent system stability and operational performance on their very own premises. This company developed a system for real-time monitoring for water -miscible fluids [11].

The effect of improved concentration control reduced annual concentration additions on one central system by 4,000 liters, amounting to a 15% reduction and a significant overall cost saving (see Figure 1).

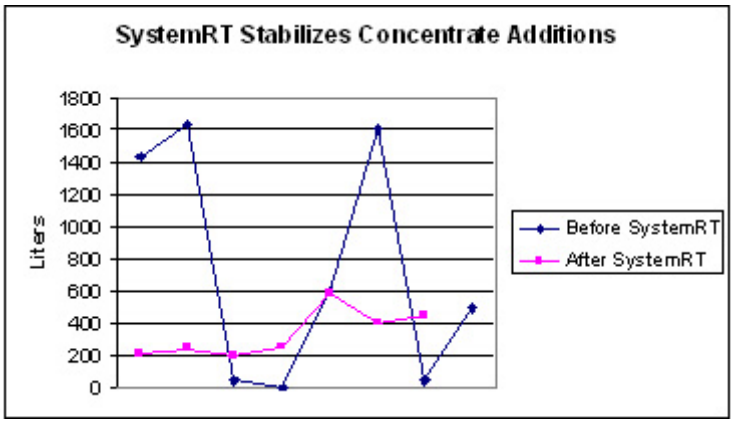

Fig. 1. *The real-time fluid monitoring and analysis capabilities of Castrol [11]*

In general there are three components of a successful fluid management program [10]:

- administration,
- fluid monitoring and maintenance,
- fluid recycling.

This section reviews the role each component plays in an effective fluid management program, but our attention is directly on fluid monitoring and maintenance.

Fluid Monitoring and Maintenance

Monitoring and maintaining fluid quality are crucial elements of a successful fluid management program [10]. A fluid must be monitored to anticipate problems. Important

aspects of fluid monitoring include system inspections and periodic measurements of fluid parameters such as concentration, biological growth, and pH. Changes from optimal fluid quality must be corrected with appropriate adjustments (such as fluid concentration adjustments, biocide addition, tramp oil and metal cuttings removal, and pH adjustment). It is important to know what changes may take place in your system and why they occur. This allows fluid management personnel to take the appropriate steps needed to bring fluid quality back on-line and prevent fluid quality problems from recurring. Despite high market requirements on the quality and environment management (e.g. standards ISO 9000, ISO 14001, QS 9000) in pratice customers show lower interest in preventive inspection of cutting fluids [5].

Over time, cutting fluids can become contaminated by chips and fines, tramp oil, bacteria, and dissolved salts. Therefore, monitoring the pH, water hardness, specific component concentration (i.e. additives, tramp oil, biocide, etc) allows fluid management personnel to take the appropriate steps needed in time to prevent failure of the fluid [12].

The proposal of methodology for in-line obtaining electrochemical parameters of cutting fluids

The proposal of methodology for the obtaining of cutting fluid parameters is based on the measuring of:

- temperature,
- concentration,
- pH.

by sensors placed in a cutting fluid container. The scheme of procedure or methodology of measuring is shown in Figure 2.

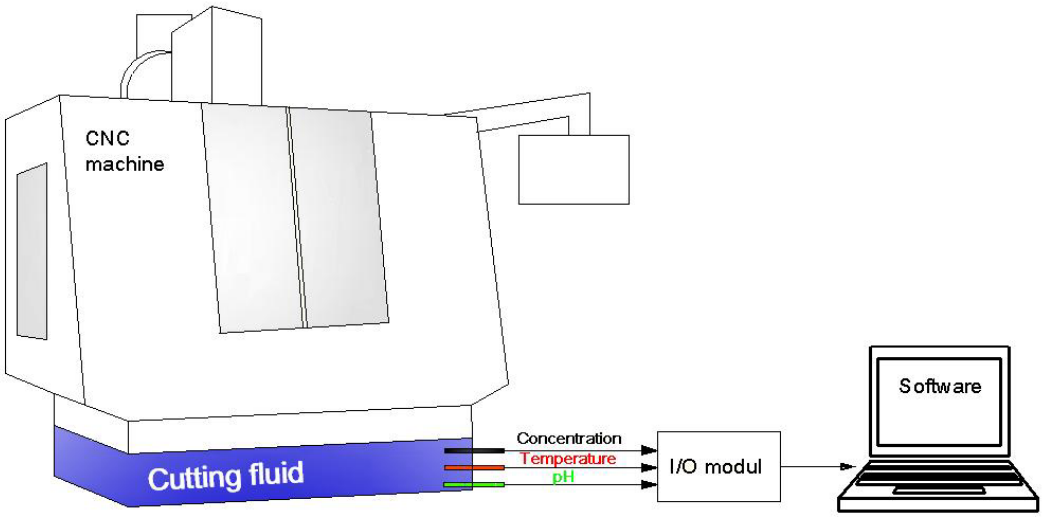

Fig. 2. *Engineering design of methodology for the in-line measuring of electrochemical parameters*

Sensors for measuring pH, concentration, and temperature will be placed on cutting fluid container. I/O module has three inputs for contact or voltage. It communicates with the computer network (Ethernet, Internet). A/D converter or I/O module transforms analog signal into digital signal.

Measuring data will be processed by software. Purposes of the in-line obtaining of physical and chemical parameters of cutting fluids are:

- provide effective consumption of cutting fluids,
- alleviate environmental impact,
- alleviate economic costs.

Scientific asset

The asset of this paper is pointing out the importance of cutting fluids in machining. The contribution is a summary of basic cutting fluid characteristics and forms how to prevent the pollution from them. Development of our own methodology for the in-line monitoring of cutting fluid parameters is the scientific contribution.

Conclusion

Cutting fluids play an important role in machining operations and impact the shop productivity, tool life, and quality of work. With time and use, fluids degrade in quality and eventually require disposal once their efficiency is lost. Fortunately, cutting fluid life may be extended significantly by implementing an effective fluid management programme. The primary objective of fluid management is to maintain fluid quality and performance through administration, monitoring, maintenance, and recycling practices. This allows machine shops to make the most cost-effective use of their fluid.

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Reviewers:

Jozef Zajac, Professor, PhD. – Faculty of Manufacturing Technologies of Technical University of Košice with a seat in Prešov

Zdenko Lipa, Professor, PhD. – Institute of Production Technologies, Faculty of Materials Science and Technology SUT, Trnava