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Effects of Minimum Quantity of Lubrication on Cutting Performance

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Abstract
Modern manufacturing requires that to be a successful organization, it must be supported by both effective & efficient maintenance. One approach to improving the performance of maintenance activities is to implement & develop a Minimum Quantity Lubrication (MQL) strategy. However it is well documented that a number of organizations are failing to successfully implement such strategies. In response to maintenance and support problems in the commercial factory, the Japanese developed and introduced the concept of MQL in 1971. Manufacturing organizations striving for world class performance have shown that the contribution of an effective maintenance strategy can be significant in providing competitive advantage through its total productive maintenance (MQL) program. MQL, a relatively new approach to the development of maintenance systems, is a scientific company-wide approach in which every employee is concerned about the maintenance and the quality and efficiency of his or her equipment.

Keywords
Cutting Fluid, Machining, Lubrication, Roughness

Technical Detail

I. Introduction
Minimum Quantity Lubrication (MQL) goes by many names. It has been referred to as "Minimal Quantity Lubrication", "Near-Dry Machining" or "NDM", "Micro-Lubrication" or "Microlubrification", "Micro-Dosing", and sometimes even gets incorrectly referred to as "mist coolant." Minimum Quantity Lubrication (MQL) is an alternative to the use of traditional metal working fluids (MWFs) in machining. You may have heard MQL referred to as "Near-Dry Machining" (NDM), "Micro-Lubrification" or "Micro-lubrication", "Micro-dosing", or even, somewhat incorrectly, referred to as "mist coolant."

II. Origin of Proposal
The origin of metal cutting can be traced to the middle ages. It was not until the middle of the 18th century, that the major developments in metal cutting were found. The introduction of the steam engine led to the advent of the first industrial revolution. This resulted in the establishment of the machine tool industry which generated cutting machines for making cylinders and flat surfaces, threads, grooves, slots and holes. The turning lathe, milling machine, shaper, saw and other machines were developed to fulfill industry's need for mass production at low cost and high accuracy. Today metal cutting has become a very large segment of our industry and indispensable to modern man. Wherever metal is used in any manmade object, one can be sure that it must have reached its final stage through processing with machine tools.

III. Definition of the Problem
The growing demand for higher productivity, product quality and overall economy in manufacturing, particularly to meet the challenges thrown by liberalization and global cost competitiveness, insists high material removal rate, high stability, high quality and long life of the cutting tools. But high production machining with high cutting velocity, feed and depth of cut are inherently associated with generation of large amount of heat and high cutting temperature. Such high cutting temperature not only reduces dimensional accuracy and tool life but also impairs the surface integrity of the product. The cutting zone temperature can only be reduced by the application of the cutting fluids. The advantages caused by the cutting fluids have been questioned, due to the several negative effects they cause. The increase awareness of environmental and health issues, industries and researchers are continuing make efforts to eliminate or reduce the consumption of cutting fluid. When inappropriately handled, cutting fluids may damage soil and water resources, causing serious loss to the environment. Therefore, the handling and disposal of cutting fluids must obey rigid rules of environmental protection. On the shop floor, the machine operators may be affected by the bad effects of cutting fluids, such as by skin and breathing problems for the companies.

IV. Objective
The objective of the present work is to examine the effects of minimum quantity lubrication on the cutting performance of medium carbon steel at different cutting velocities and feeds in terms of main cutting force and feed force, average chip-tool interface temperature, tool wear and surface finish.

V. Literature Review
Irani et al. (2005) studied that heat generation is the limiting factor in the grinding Process due to the thermal damage associated with it. To combat this energy transfer, a cutting fluid is often applied to the operation. These cutting fluids remove or limit the amount of energy transferred to the workpiece through debris flushing, lubrication and the cooling effects of the liquid. This paper reviews some of the common as well as some of the more obscure cutting fluid systems that have been employed in recent years with an emphasis on creep-feed applications.

Tawakoli et al. (2009) conducted an experimental investigation of the effects of workpiece and grinding parameters on minimum quantity lubrication-MQL grinding coolant is a term generally used to describe grinding fluids used for cooling and lubricating in grinding process. The main purposes of a grinding fluid can be categorized into lubrication, cooling, transportation of chips, cleaning of the grinding wheel and minimizing the corrosion. On the other hand, grinding fluids have negative influences on the working environment in terms of the health of the machine operator, pollution and the possibility of explosion (for oil).

Barczak et al. (2010) studied the plane surface grinding under minimum quantity lubrication (MQL) conditions. Abrasive material removal processes can be very challenging due to high power requirements and resulting high temperatures. Effective lubrication and cooling is necessary to ensure temperature levels do not become excessive. This study aims to improve understanding of the effectiveness of MQL in the fine grinding plane surface grinding regime. This paper presents a comparative study of three cooling methods: conventional flood cooling, dry grinding and grinding with MQL. Common steels EN8, M2 and EN31 were ground with a general purpose alumina wheel.

VI. Importance of the proposed project in the context of the current status

MQL can provide significant savings and improved performance in the right applications. Here are some important considerations when looking at this technology.

- MQL can be used to reduce machining costs and improve tool life for many applications involving turning, milling, drilling, reaming, tapping, routing and broaching.
- MQL is one such technology that, when applied correctly and with proper planning, can provide significant savings from multiple angles.

VII. Work Plan

A. Methodology

A detailed literature review on cutting fluids and types of cooling methods was performed to explain the background. The literature survey was undertaken from various resources such as journals, conference articles, online sources, and reference books. All relevant information was analyzed to construct a precise summary of background information. All research work is described in a very brief manner in the form of thesis methodology which is shown as figure:

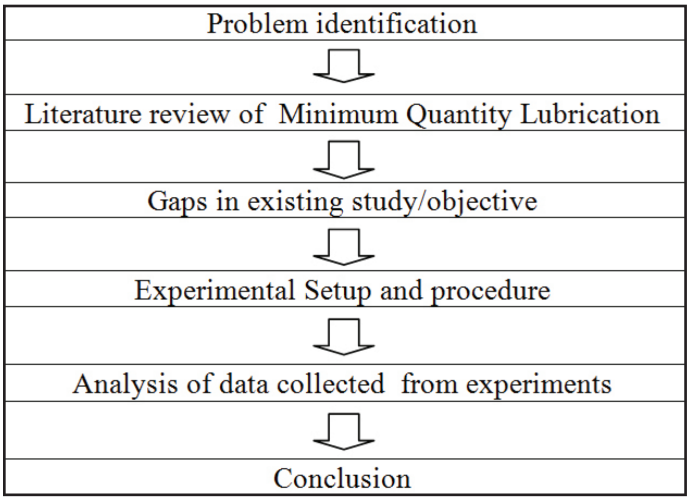

Fig. 1: Different Stages of Methodology

VIII. Conclusion

The cutting performance of MQL machining is better than that of dry and conventional flood machining taking into consideration tool wear. The MQL provides the benefits mainly by reducing the cutting temperature, which improves the chip–tool interaction and maintains sharpness of the cutting edges. The conventional flood coolant is not an effective method of cooling as it cannot penetrate up to the cutting zone interface. Such reduction in tool wear would either improvement in tool life or enhancement of productivity allowing higher cutting speed and feed.

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