Article

Minimum Quantity Lubrication in Machining

Keshav Kumar Singh[1], Rupinder Singh[2]

Abstract

Micro lubrication or also known as minimum quantity lubrication (MQL) Minimum quantity lubrication is a possible solution for the optimum lubrication system. This is an alternative between wet and dry machining. In minimum quantity lubrication system, a very small amount of lubricant is used. Flood cooling is primarily used to cool and lubricate the cutting tool and work piece interface during the machining process. Primarily they conduct heat and reduce friction. They ensure a uniform temperature of the work piece and tool and help to maintain tolerances this article, the studies about minimum quantity lubrication was examined and different types of MQL systems, comparison of MQL coolant system with conventional coolant systems, applications and advantages of MQL coolant system.

Keywords: Cutting fluid, Green machining, Minimum quantity lubrication, Surface roughness

Introduction

Machining can be defined as a process which is used techniques for producing different components. It is a process of removing material from the work piece in the form of chips with the use of cutting tools. The cutting fluids are very important part of this process. Metal cutting also known as machining is one of the most used techniques for producing different components. Basically cutting fluids are used for effectively cooling and lubrication to reduce the friction between tool and work piece.

Aims of the MQL Coolant System

The aim of MQL machining:

Reduction of thermal stresses at the tool point
Less tool wear
Effective chip evacuation from deep holes
Reduction of cooling lubricant requirement
High cooling and lubrication effect especially in deep holes
Reduction in component clean
Reduction in cooling lubricant disposal costs

[1]P.G Student, [2]Assistant Professor, Department of Mechanical Engineering, Rayat Bahra University, Kharar, India.

Correspondence: Mr. Keshav Kumar Singh, Department of Mechanical Engineering, Rayat Bahra University, Kharar, India.

E-mail Id: keshavpanditji786@gmail.com

Orcid Id: http://orcid.org/0000-0002-9661-4765

How to cite this article: Singh KK, Rupinder Singh. Minimum Quantity Lubrication in Machining. *J Adv Res Prod Ind Eng 2017;* 4(1&2): 26-29.

ISSN: 2456-429X

There are several functions of cutting fluids:

- Cooling and cleaning
- Lubrication
- Improves tool life
- Flushing away the chips
- Improves surface finish
- Prevention of corrosion

The removed material called chip slides on the tool face and leaves the work piece material. Machining process are surface residual stresses high of magnitude, which are tensile. Other effects such as surface cracking, and difficulty in maintaining close tolerances on account of warping, are encountered during machining. The residual stress state in a piece depends on the material of the component and on the cutting parameters employed: cutting speed, cutting feed, depth of cut, kind of cutting tool wear of the tool, lubrication, etc Surface roughness is mainly a result of process parameters such as tool geometry and cutting conditions.

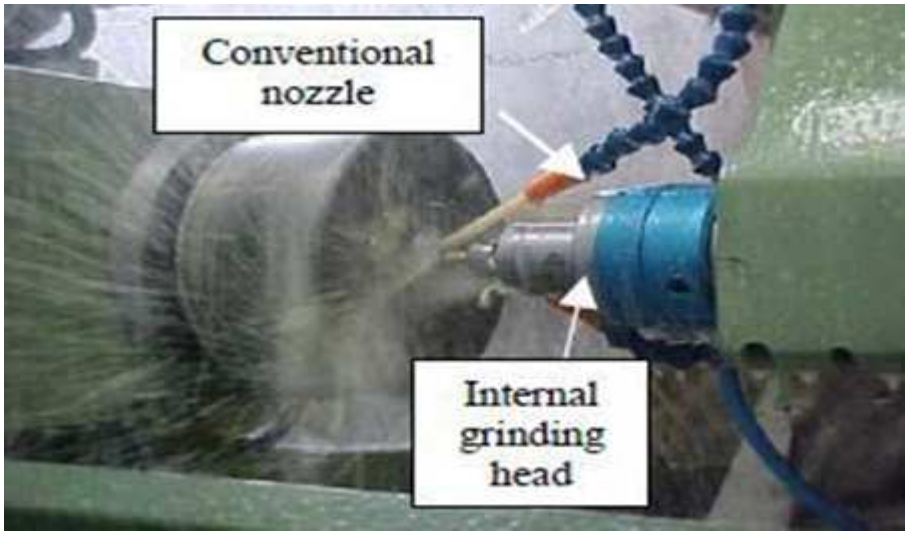

Figure 1.Conventional Cooling System under Operation

Literature Review

1. Dhar et al., 2006 studied the role of MQL in turning AISI-4340 steel by uncoated carbide insert and observed that the cutting performance of MQL machining was better than that of dry and conventional machining with flood cutting fluid supply because MQL provides the benefits mainly by reducing the cutting temperature, which improves the chip–tool interaction and maintains sharpness of the cutting edges.
2. In another study Vamsi Krishna P et al. studied the performance of nano boric acid suspensions in SAE-40 and coconut oil during turning of AISI 1040 steel and 50µm particle size boric acid solid lubricants suspensions were used and studied that thermal conductivity increased and specific heat decreased with the percentage increase in nano boric acid in the base oil.[4]
3. In the study Braga et al., 2002 studied about the uncoated and diamond coated carbide drills. While using minimal lubrication in the drilling of aluminum–silicon alloys (A356). He observed that the holes obtained with the MQL system presented are of better quality than obtained with flood of abundant soluble oil,
4. Nam JS et al. studied the micro-drilling process with the nano fluid minimum quantity lubrication (MQL). In the nano fluid MQL, nano-diamond particles having the diameter of 30 mm were used with the base fluids of paraffin and vegetable oils and observed that the number of drilled holes was significantly increased when the pure MQL and nano fluid MQL being applied, nano fluid MQL significantly reduce the magnitudes of drilling torques and thrust forces.[6]

Cutting Fluids Characteristics

Basically cutting fluids have three characteristics. These are:

- Cooling effect
- Lubrication effect
- Flushing away chips from the cutting zone

Selection Criteria of Cutting Fluids

Selection of suitable cutting fluid is greatly depending on these factors.

- Types of machining process

ISSN: 2456-429X

- Types of work material
- Types of cutting tool material

Cutting fluids should have the following properties to fulfill their functions properly

- Good lubrication properties
- High cooling capacity
- Low viscosity to provide free flow of cutting fluid
- Chemically stable and non-corrosive
- High flash point to reduce fire risks
- Allergy free
- Less evaporative
- Low cost

According to chemical formulations, cutting fluids are classified into four categories: cutting oils (neat oils or mineral oils), soluble oils (emulsified oils, emulsions), synthetic (chemical) fluids, semi- synthetic fluids

Selection Criteria of Cutting Fluids

Selection of suitable cutting fluid is greatly depending on these factors.

- Types of machining process
- Types of work material
- Types of cutting tool material

Minimum Quantity Lubrication

In the MQL the conventional system is the most efficient system used in the MQL. In this system the coolant is placed on the rack face of the tool. In this system due to the obstacles faced by the cutting chip the coolant does not reach to its desired position. Some alternatives has been sought to minimize or even avoid the use of these conventional cutting fluids in machining operations so the alternative methods are used for the proper lubrication such as dry machining and MQL.

Developed system based on simple principle Compressed air passed through ventures, oil siphoned from reservoir by air flow, is atomized into a fine spray. A typical system consists of air filter, Pressure regulator, spray control valve with distributor nozzle, solenoid valve, switches.

Figure 2.Position of the MQL Spray Nozzle in the Cutting Region

Need of MQL

In flood cutting, because of lubricant there is problem of disposal and more maintains and it is expensive process.

Internally MQL is a conversion of production process from wet to dry machining help to motivate Personnel; externally it contributes a better corporate image.

MQL Systems

Basically, MQL system is used for the supply of an appropriate lubricant to the contact point of the tool and work piece. Different systems are available for

this purpose. The coolant with MQL can be supplied in two different ways:

- External feed system
- Internal feed system

Lubricants for Minimum Quantity Lubrication

When choosing a suitable MQL lubricant, the user should take into account the criteria below.

a. **Smell:** The smell of the lubricant is not inconsequential. Spraying the lubricant can cause the smell to be intensified.

b. **Spray ability:** The lubricant should spray easily and, especially with 1-channel systems, be able to produce a stable aerosol (oil-air mixture).

c. **Additives:** The additives should be adjusted to the processing requirements, particularly when processing non-ferrous metals and difficult-to-cut steels.

Advantages of MQL

- Due to the omission of supply and disposal of coolant, high savings are possible.
- After optimization of processes, a higher tool life can be expected.
- No used emulsions will accumulate.
- Accidents due to large quantities of leaking coolant are avoided.
- Simple adaptation
- Low investment costs

Conclusion

From this study, we concluded that:

- These literature clearly reveal that MQL system provides better performance than dry machining
- The tool performance can be enhanced by using MQL under all cutting speeds.
- MQL is less polluted, environmentally friendly are reduced while disposal.
- MQL gave the best performance in terms of the surface roughness, feed forces, tool wears and surface quality.
- Improved Surface finish due to the reduction of wear and damage at tool tip by minimum Quantity lubrication.

References

1. Rahim EA, Sasahara H. A study of the effect of palm oil as MQL lubricant on high-speed drilling of titanium alloys. *Tribology International* 2011; 44: 309-17.
2. Priarone PC, Robiglio M, Settineri L, et al. Milling and turning of titanium aluminides by using minimum quantity lubrication. *Procedia CIRP* 2014; 24: 62-7.
3. Sharma VS, Singh GR, Sorby K. A review on minimum quantity lubrication for machining processes. *Materials and Manufacturing Processes* 2015; 30: 935-53.
4. Çakir A. Ozben YT. Selection of cutting fluids in machining processes. *JAMME* 2007; 25(2).
5. Vamsi Krishna P, Srikant RR, Nageswara Rao D. Experimental investigation on the performance of nano boric acid suspensions in SAE-40 and coconut oil during turning of AISI 1040 steel. *International Journal of Machine Tools and Manufacture* 2010; 50: 911-6.
6. Nam JS, Pil-Ho L, Lee SW. Experimental characterization of micro-drilling process us ingnanofluid minimum quantity lubrication. *International Journal of Machine Tools and Manufacture* 2011; 51: 649-52.
7. Blenkowski K. Coolants and lubricants. Part 1: the truth, Manufacturing Engineering. 1993. pp. 90-96.
8. Klocke F, Gerschwiler K, Fritsch R, et al. PVD-coated tools and native ester - an advanced system for environmentally friendly machining. *Surface Coating Technology* 2006; 201: 4389-94.
9. Srikant RR, Rao DN. Experimental investigations on the influence of emulsifier content in cutting fluids on machined surface. *Journal of Engineering Tribology* 2009; 223: 195-201.