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A Review on MQL in Green Environments Used For Machining Process

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ABSTRACT
It is realized that these fluids are a serious damage to the environment and to the health of the operator working with it. Many alternatives were developed to minimize the quantity of cutting fluid used. The purpose of this article is to review the relevant literature in machining using minimum quantity lubrication In green environments this research project an on-going comparative study will be made for tool wear and surface roughness by varying cutting parameters under flood , air , dry and Minimum Quantity Lubrication (MQL) green environment while machining different materials like high speed steel ,medium carbon steel etc with . The results application of MQL technique will significantly helps to obtain better performance in compare to dry air and flood condition. It is mainly focused on investigating various aspect of machining process from an environmental perspective.
Keywords - Minimum Quantity lubrication with vegetable oil and different materials

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I. INTRODUCTION

The interest of techniques in pollution control and its prevention is rapidly growing. For pollution controls several industries , including manufacturing ,to develop and implement various environmentally friendly strategies like MQL in green environments .There is an ongoing search for new and innovative ways by which industry can lessen its impact on the environment. Efforts are currently focused to efficient consumption of resources and conserved energy , minimize the environmental effects of energy production . The cutting fluids performs the vital role in various machining processes.

I.I CUTTING FLUIDS

Cutting fluids are widely used in machining operations to serve the purpose of reducing thermal deformation by cooling the machining zone and improving the surface finish by providing good lubrication

I.II Types of cutting fluids

There are two broad categories into which cutting fluids may be classified:

- Water miscible cutting fluids
- Mineral oil based cutting fluids
- Nano lubrications
- MQL

Water miscible fluids : Water miscible cutting fluids are those cutting fluids which contain water as the main base flui d. Water is a fluid which has got excellent cooling property. Thus water miscible cutting fluids have good heat absorbing characteristics. Water miscible fluids consist of water soluble oils mixed with water. These water soluble oils are generally emulsifiers (soap like substance). These oils when mixed with water in a small quantity produce a milky white material which is then supplied to the cutting area.

Mineral oil based cutting fluids :These oils do not get mixed with water. They can be used as mixtures of mineral or vegetable oils. Several additive compounds such as sulphur, phosphorous, chlorine based components can be added to the base cutting fluids in order to improve their cooling and lubricating properties.

Nano lubrication : Nano lubrication can be defined as the process of cooling and lubricating the cutting zone during any machining operation by employing Nanofluid instead of the normally used cutting fluids.

Nanofluid : Nanofluid are prepared by mixing a specific amount of nanoparticles (having size of the order of few nanometers) into the cutting fluid. The nanoparticles on account of their different specific densities may have the tendency to settle down or float depending upon the cutting fluid used. Thus, the nanoparticles are mixed thoroughly into the cutting fluid by using an ultrasonic vibrator for approximately 48 hours. Nanoparticles, on account of their very small size have got high surface area to volume ratio. Due to their large surface area, their heat dissipating capacity increases to a great extent. Thus, nanoparticles have got excellent heat dissipating characteristics. Different types of nanoparticles can be used to enhance the cooling and lubricating properties of the cutting fluids. Some of the nanoparticles that can be employed in the cutting fluids for cooling and lubricating purposes are:

- Molybdenum disulfide nanoparticles
- Aluminum oxide nanoparticles
- Graphite nanoparticles
- Carbon nanotubes
- Silver nanoparticles etc.

II. MINIMUM QUANTITY LUBRICATION

The main aim of minimum quantity lubrication (MQL) is to reap the benefits of cutting fluids without getting affected with the harmful effects of the cutting fluids. It involves the usage of minimal quantity of cutting fluid with a typical flow rate of 50-500 ml/h which is directly applied to the cutting zone thereby avoiding the need of fluid disposal as it happens in flood cooling. Since MQL involves significantly lesser amount of cutting fluid, this phenomenon is popularly referred to as 'near dry machining' or 'micro lubrication' or 'spatter lubrication'. In MQL process, oil is mixed with high-pressure air and the resulting aerosol is supplied near to the cutting edge. This aerosol impinges at high speed on the cutting zone through the nozzle. Air in the aerosol provides the cooling function and chip removal, whereas oil provides lubrication and cooling by droplet evaporation. The flow of lubricant in MQL process varies from 10 to 100ml/hr and air pressure varies from 4 to 6.5 Kgf/cm2 (Silva et al., 2005). Different ranges for flow rate were also reported in literature such as 50 to 500 ml/h (Dhar et al., 2006a) and 2 to 300 ml/h (Zhong et al., 2010). However, in industrial applications consumption of oil is approximately in the range of 10-100 ml/h (Kamata and Obikawa, 2007). When the flow rate of cutting fluid in MQL is less than or equal to 1 ml/h it is termed as Micro-Liter Lubrication (μLL) (Obikawa et al., 2008). As the quantity of cutting fluid in MQL is very less (in ml/h instead of l/min) in comparison to flood cooling, the process is also known as Near Dry Machining. If oil is used as fluid medium in NDM, better lubrication is obtained with slight cooling effect whereas, when emulsion, water or air (cold or liquid) were used, better cooling is achieved with slight/no lubrication so, the processes were termed as Minimum Quantity Lubrication and Minimum Quantity Cooling respectively (Weinert et al., 2004). NDM can be classified on the basis of method of aerosol spray and aerosol composition as shown in Figure 1.

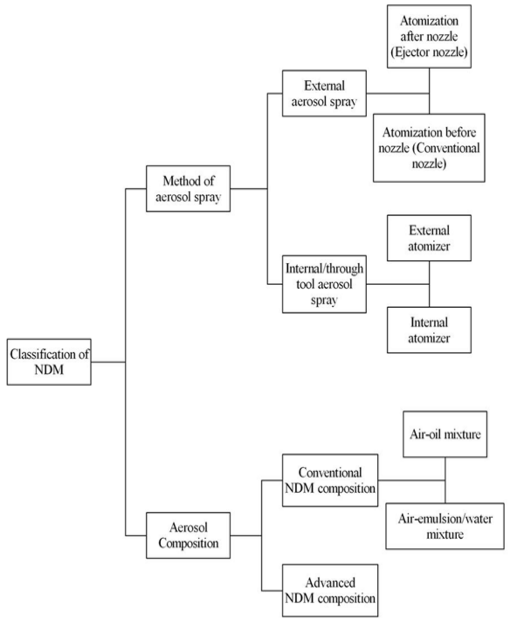

Fig.1. Classification of Near Dry machining (Astakhov, 2008; Weinert et al., 2004)

As little quantity of cutting fluid was utilized in MQL process, the cutting fluid should possess significantly higher lubrication qualities than mineral oil and synthetic ester oil are two viable alternatives. Vegetable oils are nontoxic as they are based on extract from plants. Molecules of these oils are long, heavy and dipolar in nature and provides greater capacity to absorb pressure. Higher viscosity index provides stable lubrication in operating temperature range and higher flash point provides opportunity to increase metal removal rate due to reduced smoke.

Possible parameters and machining conditions affecting the performance of MQL assisted machining are illustrated in fishbone diagram as shown in Figure 2.

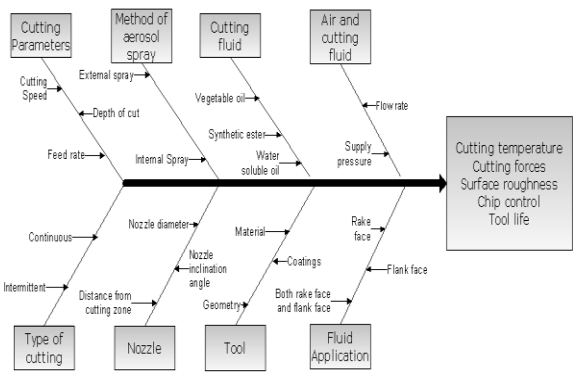

Fig.2. Fishbone diagram showing cause and effect in MQL assisted machining.

III. METHODOLOGY

This method involves the application of an aerosol of highly compressed air (typical pressure of air = 4-6 bar) and cutting fluid (lubricant) through a specially designed nozzle with hole diameter of magnitude 1-2mm. In this method, as the cutting fluid in the form of small droplets of aerosol comes in contact with the heated cutting zone, it evaporates extracting the latent heat from the machining area. Thus, this method involves removal of heat by evaporative transfer rather than convective heat transfer method. Since, evaporative heat transfer method is more efficient in terms of extracting heat and also there is no waste disposal problem, MQL surely has an extra advantage with respect to conventional flood cooling.

I.IV.I There are two methods of mixing air and lubricant in MQL method.

1. Mixing inside the nozzle 2. Mixing outside the nozzle .

In the first method, the lubricant and air is mixed just before reaching the nozzle in a mixing chamber. The oil-mist is then supplied through the nozzle at high pressure onto the cutting zone. The oil performs the lubricating function while highly pressurized compressed air performs the cooling action.

In the second method, the mixing of oil and compressed air is done in a separate mixing chamber. This section provides the review of previous research work carried out in the area of MQL assisted turning to highlight the outcomes. This review was conducted material wise to provide a comprehensive overview of research outcomes for a particular work-material. Fig 3. shows the schematics diagram of MQL.

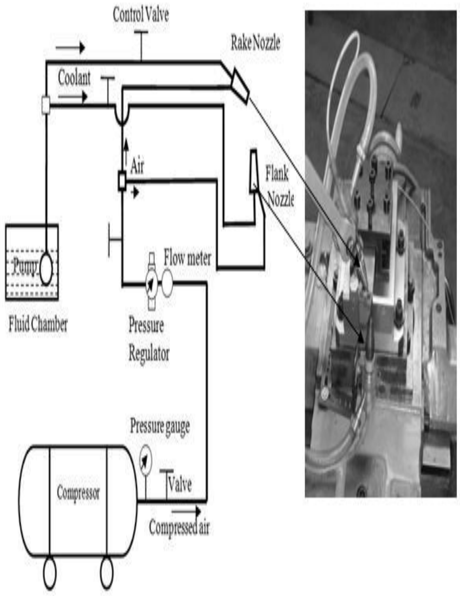

Fig.3. Schematic diagram of MQL

IV . CONCLUSION

From the discussion presented in this paper, it is apparent that MQL systems possess many advantages over dry, air and flood coolant system. However, they also require some accessories and some attachments of machine tools for obtaining the best performance out of them and study **Minimum quantity lubrication in** green environments **in turning and milling on cutting force , temperature , tool life ,surface roughness and chip morphology** When the flood coolant system is not present, the machine tools should be equipped with a chip removal system.

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