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# Effect of Minimum Quantity Lubrication in Machining Using Different Vegetable Oils

**Satwinder Kaur[1], Kulwinder Garg[2] and Rutash Mittal[3]**
[1]MTech Student, [2&3]Assistant Professor
Department of Mechanical Engineering, MIMIT, Malout, Punjab, India
E-Mail: aarorasatwinder6@gmail.com
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***Abstract*** **- In metal industries and researchers are trying to reduce the use of coolant lubricant fluid in metal cutting to give the better performance, health safety, economic benefits and reduction in environmental pollution. Lubrication is necessary for the cutting operations to avoid the surface damages. The MQL gives better result over the conventional flood cooling as it effectively reduce the tool wear through mixture of air and lubricant and also impairs the surface finish of product. The minimization of cutting fluid leads to saving the lubrication cost and also saves machine cleaning time. This study deals with experimental investigation on role of different vegetable oils tool wear and surface finish. Experiments were carried out by plain turning of round bar of SAE 1018. The aerosol based on different vegetable oils was used to evaluate the tool performance and surface finish at different speed combinations. It was observed that Aerosol consist of Canola oil gives less tool wear and comparative surface finish as compared to Sunflower and Soybean oil. SEM results also analyzed in terms of tool wear.**
***Keywords:*** **Lubrications Conditions, MQL, Tool Wear and Surface Roughness**

## I. INTRODUCTION

Machining is the process of removal of unwanted material from the work-piece in the form of chips. So as to get a finished product of desired shape it is usually done by using machine and cutting tools. The growing demands of industries for high productivity of machining need high removal rates, which are uses high cutting speed and feed rate but high removal rate produces increased surface roughness and tool wear. Thus cutting environment is identifies as critical reason to produce surface finish also tool life increase. There are several types of metal cutting fluids that are classified as straight fluid, synthetic fluid and semi-synthetic fluids, soluble fluids and vegetable based cutting fluids. Petrochemical and synthetic based cutting fluid many negative effects [1]. Fig. 1 shows the adverse effect associated with use of metal working fluid.

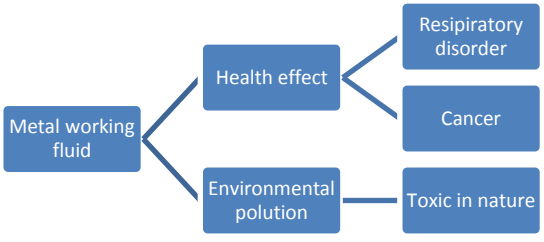


Fig. 1 Effects of metal working fluid

These are environment unfriendly and toxic in nature. The using less harmful cutting fluids suggests the semi-dry lubrication technique which use very amount of cutting lubricants. A number of researchers have already been carried out in this area which inevitably showed the effectiveness of vegetable oil as coolant/lubricant in different machining operation [2]. Vegetables oils are nontoxic to the environment friendly these types of fluids are renewable and possess high biodegrade-ability. Biodegradable and renewable oil since it is coming from an agricultural product. No harmful additives added unlike the petroleum product the use the EP additives such as chlorine and sulfur [3]. They have also good lubrication capability. In addition to cooling action, cutting fluid also lubricate the machining zone leading to reduced cutting forces.

Application of fluid also helps in achieving longer tool life and better quality of the product [4]. Also lubricant plays an important role as it carry chips and the cleaning of tool-w/p, wastage of coolant are avoided in MQL. So MQL machining was as an alternative to flood and internal high pressure coolant supply to reduce the uses of metal working fluid consumption [5-7]. MQL is a technique which spray small amount of cutting fluid (in the range of about 10-100 ml/h) to the cutting zone area with aid of compressed air. Using MQL, vegetable cutting fluid can penetrate deep into the tool work-piece interface, hence positive results [8]. MQL has been applied proactively in different machining process such as milling, turning, drilling and grinding [9]. Fig. 2 shows number of machining operation performed using vegetable fluid.

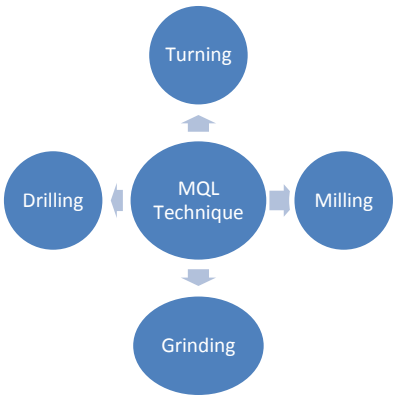


Fig. 2 Applicability of MQL technique in machining

An official report from German Government for a project called "Research for tomorrow production", which involved several large companies like Bosch and Daimler, has indicated MQL's capability and cost-saving [10].This paper work look at the effect of different vegetable oil will be used to evaluate the tool performance surface finish when turning on various speed feed and constant depth of cut. Also choose the canola oil, sunflower oil and soybean oil as vegetable based.

## II. EXPERIMENTAL DETAILS

Turning experiments were carried out for different cutting fluid and the results were investigated. Lathe machine is used for turning the SAE 1018 mild steel round bar having diameter of 36mm and length of rod 520mm. Fig. 3 shows the minimum quantity lubrication setup. It consists of nozzle, oil tank, oil pressure regulator, air supply, air pressure regulator and mixing chamber.

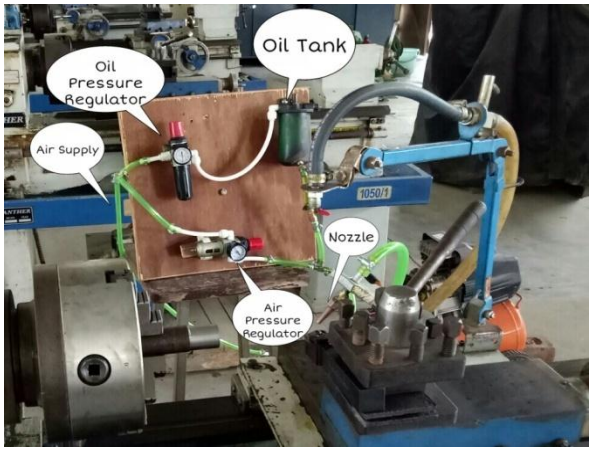


Fig. 3 MQL Experimental Setup

The mixing chamber was connected at the nozzle inlet by very small diameter flexible tube. Mixture of compressed air and vegetable oil were injected at work-piece and insert interface point.

The experiments conducted on Panther Lathe machine and the selected conditions values are given below:

1. *Cutting Insert:* Coated carbide bit PS08 which could gives higher heat resistance and tool life is evaluated by measuring nose wear with standard cutting geometry. Tool wear analysis was examined using Co-ordinate measuring machine (CMM).
2. *Work-Piece Materials:* SAE1018 mild steel bar with the chemical composition of this work-piece was 0.17% C, 0.700%Mn, 0.035% P, 0.012% S and 0.240%Si. Surface roughness was measured using Mitutoyo SURFTEST-4.
3. *Cutting Conditions:* Cutting speed of 288 and 384, depth of cut and flow rate of lubricant were kept constant at 0.5mm and 80ml/h, respectively. The cutting fluids used as based vegetables oils sunflower oils, Soybean oils and canola oils.

## III. RESULTS AND DISCUSSION

In order to evaluate the machining process performance, surface roughness and tool were compared under various cutting conditions vegetables oil based cutting fluids. Cutting speed also affects the machining. Cutting conditions has a significant influence on nose wear of carbide bit and surface roughness of specimen.

### *A. Effects of MQL on Tool Wear*

Tool wear is mainly depending upon the tool work material and machining conditions. The turning test conducted to study the variation tool wear under different vegetables used. The selection of good cutting fluid depends on its properties.

The cutting fluid should posses' high flash point and fire points, as it should not catch fire at high temperature. Uses of vegetable oil by MQL mainly reduced the wear of main cutting edge. The nose tool wear measured after each operation with the help of CMM. Fig. 4 shows that different vegetable oils used at different machining conditions. As per the tool wear measurement the canola oil gives less tool wear as compared to sunflower oil soybean oil.

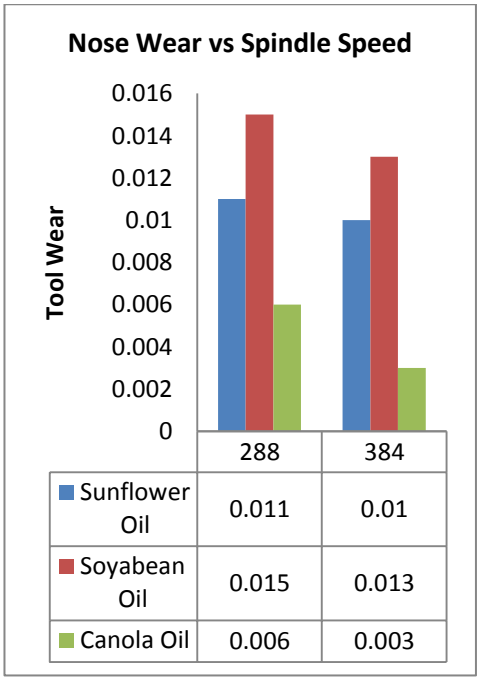


Fig. 4 Tool wear at different speed by uses different vegetable oils

### *B. Effects of MQL on Surface Roughness*

Surface roughness is also an important index for the life of the machined components. Regular feed marks left by the tool tip on the finished surface, built up edge formation and irregular deformation of the cutting edge at the tool tip due to chipping.

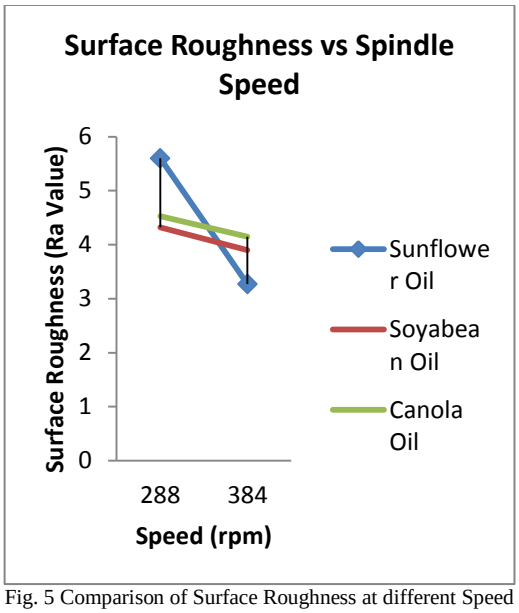


Fig. 5 Comparison of Surface Roughness at different Speed

The variation in surface roughness investigated during turning SAE 1018 steel under MQL conditions. Fig. 5 indicates the surface roughness (Ra) of the work-piece achieve under three different lubricant conditions. The result revealed that the minimum surface roughness can be achieved at the speed of 384 m/min, and minimum quantity lubrication canola oils at the flow rate of 80ml/hr.

## IV CONCLUSION

The experiments on the effect of different cutting speed and MQL condition on finish turning SAE 1018 using coated carbide insert. The performance of three types of vegetables based cutting fluid namely canola, sunflower and soybean oils were evaluated during machining. Canola oil provided reduced tool wear, improves tool life and better surface finish as compared to sunflower and soybean oil. Using vegetables oil not only effects on tool wear and surface roughness in SAE1018 turning but can also behave the nontoxic and environment friendly in nature.

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