Effect of Lubrication Condition on Surface Roughness in Facing Operation

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ABSTRACT

Smooth surface and lower friction is the first and foremost thinking in modern manufacturing process. So, after facing operation a smoother surface is first requirement. During facing operation high friction increases the temperature at high level. Such high temperature causes various problems like a high tool wear, large heat affected zone, change in hardness and microstructure of the work piece, burning and its consequence and high surface roughness. Application of conventional cutting fluids reduces the above problems to some extent through cooling and lubricating of the facing zone. But its result changes with the change of cutting fluid utilization and change of the cutting speed. In this research work different amount of cutting fluid is used and its effect on the surface roughness has investigated for the three different materials like mild steel, aluminium & cast iron. The facing operation was done for a constant spindle speed and other parameter like feed rate kept constant for dry, semi dry and wet machining. The experimental results reveal that lubrication condition during facing operation effect roughness of those metal surfaces. The optimum cutting fluids lead to economical benefit and environmental friendly machining.

Keyword: *- Surface Roughness, Cutting speed, Cutting fluid, Lubricant.*

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1. INTRODUCTION

Facing is the process of removing metal from the end of a workpiece to produce a flat surface. The use of cutting fluids in metal cutting was first reported in 1894 by F. Taylor who noticed that cutting speed could be increased up to 33% without reducing tool life by applying large amounts of water in the cutting zone [1]. Cutting fluids increase the tool life and improve the efficiency of the production systems providing both cooling and lubricating the work surface. Cutting fluids are extensively used in machining operations as it removes

Chip from inside the holes and outside edges, thus preventing metal breakage [2]. Higher surface finish quality and better dimensional accuracy are also obtained from cutting fluids [3]. Many types of cutting fluids namely, straight oils, soluble oils, synthetic and semi synthetic are widely used in metal cutting processes. Bio-based cutting fluids have the potential to reduce the waste treatment costs due to their inherently higher biodegradability and may reduce the occupational health risks associated with petroleum-oil-based cutting fluids since they have lower toxicity. The output is a healthier and cleaner in the work environment, with less mist in the air. For that reason, cutting fluids developed from vegetable oil in the present study are environmentally friendly and have a good lubricating ability as compared to others.

There is a wide variety of cutting fluids available today. Many new coolants have been developed to meet the needs of new materials, new cutting tools, and new coatings on cutting tools [4]. The goal of cutting fluid in facing operations must be to improve productivity and reduce costs. This is accomplished by facing at the highest practical speed while maintaining practical tool life, reducing scrap, and producing parts with the desired surface quality. Proper selection and use of cutting fluids can help achieve all of these goals.

In facing almost all of the energy expended in cutting is transformed into heat. The deformation of the metal to create chips and the friction of the chip sliding across the cutting tool produce heat. The primary function of cutting fluids is to cool the tool, work piece, and chip, reduce friction at the sliding contacts, and prevent or reduce the welding or adhesion on the contact edges that causes a built-up edge on the cutting tool or insert. Cutting fluids also help prevent rust and corrosion and flush chips away.

The main aim of all machining including facing operations is to obtain to lower machining costs by improving of quality and productivity. This aim can be achieved by machining at the highest cutting speed with long tool life, fewest part rejects (scrap) and minimum downtime. During machining a lot of parameters affecting the cutting performance. Some machining operations can be carried out "dry", but cutting fluids have been used extensively and play a significant role in machining areas. Cutting fluids affect the productivity of machining operations, tool life, and quality of work piece and prevent the cutting tool and machine from overheating as well. The proper application of cutting fluid provides higher cutting speeds and higher feed rates possible. In general, a successful cutting fluid must not only improve the machining process performance, but also fulfil a number of requirements which are non-toxic, non-harmful to health for operators, not a fire hazard, not smoke or fog in use and cost less. One of the drawbacks of using cutting fluids is the waste disposal after being used [4].

Emulsion is a term that describes soluble oils. An emulsion is a suspension of oil droplets in water. Soluble oils are mineral oils that contain emulsifiers. Emulsifiers are soap-like materials that allow the oil to mix with water. Emulsions (soluble oils) when mixed with water produce a milky white coolant. Lean concentrations (more water-less oil) provide better cooling but less lubrication. Rich concentrations (less water- more oil) have better lubrication qualities but poorer cooling [6].

There are different types of soluble cutting fluids available including extreme pressure soluble oils. These should be used for extreme machining conditions where it is necessary to reduce friction where the tool and work piece contact each other.

The application of cutting fluids is another alternative to obtain higher material removal rates. Cutting fluids have been used widespread in all machining processes. However, because of their damaging influences on the environment, their applications have been limited in machining processes. New approaches for elimination of cutting fluids application in machining processes have been examined and "dry machining" was presented as an important solution. The development of new cutting tool materials also helped dry machining method to be a positive solution for cutting fluids applications.

2. TYPES OF MACHINING

2.1 DRY MACHINING

Dry machining is defined as the machining where lubricant or coolant (cutting fluid) is not used during operations.

Due to the increasing burden of costs related to the protection of the environment the manufacturing industry increasingly employing machines with lubrication systems that optimize the performance and reduce the use of lubricants. There is also a huge decrease in the consumption of water and oil.

This possibility increases the prospects of chips damaging the tool and the workpiece surface because there is no mechanism in place for their removal. Studies shows that, dry machining proved lacking because feed rates needed to be decreased in order to avoid compromising surface finish requirements.

At higher speeds and feeds dry machining fail to meet the expectation of better surface finish.

2.2 SEMI-DRY MACHINING

Near-dry or semi dry machining involves the application of small amounts of lubricant to the tool or workpiece interface.

Eliminates flood coolant, no waste disposal problems, longer tool life, safer working Conditions, less fluid consumption, long term cost savings, cleaner machine operation, less machine maintenance.

Cost of buying is high and health problems like skin irritation or allergic reactions, asthma, bronchitis and other respiratory difficulties from handling or working around conventional coolants.

2.3 WET MACHINING

In wet machining, both the tool and the work piece must be supplied with the right quantity of coolant.it is also known as flood cooling machining.

Eliminates flood coolant, no waste disposal problems, longer tool life, safer working Conditions, less fluid consumption, long term cost savings, cleaner machine operation, less machine maintenance.

In addition, the lubricating capabilities of cutting fluids reduce friction, increase tool life, reduce the tendency to form a built-up edge on the cutter and they improve workpiece surface finish.

Cost of buying is high and health problems like allergic reactions, respiratory irritation and even poisoning and infection in certain individuals from handling or working around conventional coolants.

3. MEASUREMENT OF SURFACE ROUGHNESS

3.1 DIGITAL SURFACE ROUGHNESS TESTER

It is the latest addition to our growing line of precision surface roughness testers and profilometers. This roughness tester is "state of the art" with a full slate of advanced features along with precision and accuracy that you demand. Extremely sensitive and highly accurate readings from the surface roughness tester are offered via 15 popular surface roughness scales including Ra, Rq(Rms), Rt, Rz and Rmax.

3.2 PROCEDURE OF MEASUREMENT SURFACE ROUGHNESS

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4. EXPERIMENTAL RESULTS

In this thesis work during facing operation depth of cut and feed rate was remained constant and it is 0.5mm.
Figure 1 shows average roughness of Aluminium for dry, semi-dry and wet machining at different cutting speed in facing operation. From this figure we can see that for dry machining at lower (110,150 and 200rpm) speed change the average roughness change is also too small. But at higher speed change it increases rapidly. For semi-dry machining increase of average roughness is gradual and for wet machining when the speed is lower like 100 or 150 rpm then at those speeds change of average roughness is almost same but when speed is high then average roughness increases abruptly. The graph also shows that at semi-dry machining surface has lower roughness than the other machining at most of the cases. So, for manufacturing semi-dry machining is more effective than dry and wet for Aluminium.

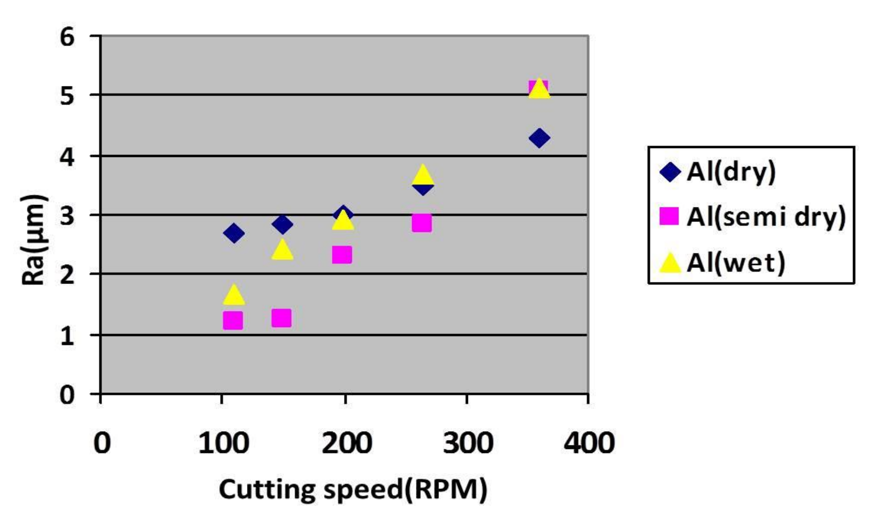

Fig.1: Average roughness of Aluminium for dry, semi-dry and wet machining

Figure 2 shows average roughness of Cast Iron for dry, semi-dry and wet machining at different cutting speed.

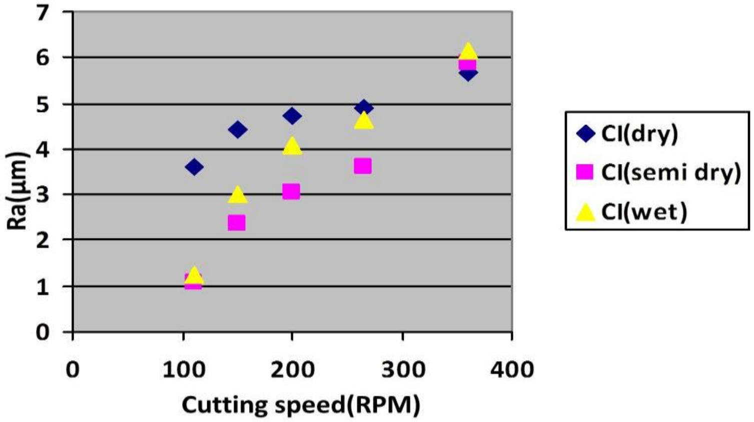

Fig.2: Average roughness of Cast iron for dry, semi-dry and wet machining

From fig. 2 it shows that for dry machining the average roughness is increases gradually with respect to cutting speed. Also for semi-dry and wet machining at lower (110,150,200 and 265rpm) speed change of average roughness is gradual. But at higher speed change of average roughness is more rapid. The graph also indicates that at semi-dry machining surface has lower roughness than dry and wet machining at most of the cases. So, for manufacturing at semi-dry machining is more effective than dry and wet for Cast Iron.

Figure 3 shows the average roughness of Mild Steel for dry, semi-dry and wet machining at different cutting speed of facing operation.

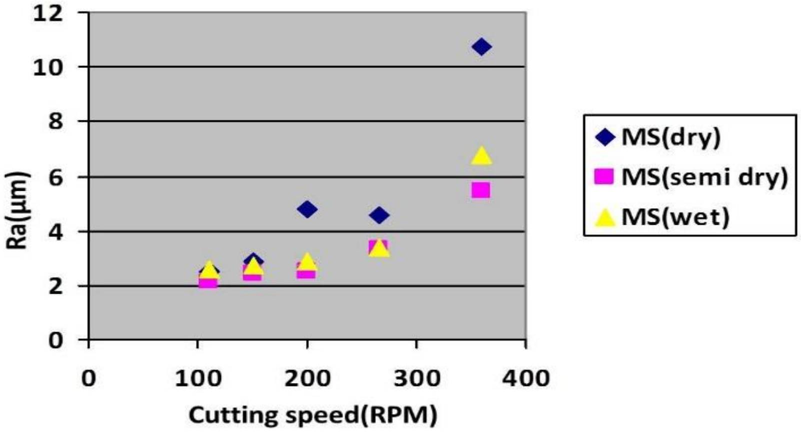

Fig.3 Average roughness of Mild Steel for dry, semi-dry and wet machining

For dry machining average roughness is asymmetrical at figure 3. When speed is changed at small variation then average roughness increases in a regular way for both semi-dry and wet. But at larger variation of speed creates large roughness. The graph also shows that at semi-dry machining surface has lower roughness than the other machining at most of the cases. So, for manufacturing semi-dry machining is more effective than dry and wet for Cast Iron.

Micro-structural analysis

Microscopic images are shown below for different materials of different lubrication condition at 110rpm cutting speed.

In figure 4 microscopic images of Aluminium for dry, semi-dry and wet machining are displayed. In these images, figure 4(b) can be separated from 4(a) and 4(c) for better surface finish and lesser dark spots. So, it can be say that semi-dry machining shows better surface finish. Moreover, in semi dry machining contraction between cutting tool and workpiece material is favorable.

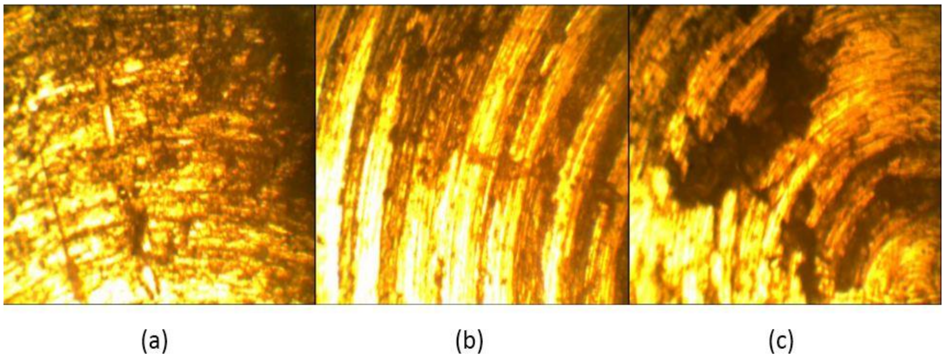
(a) (b) (c)

Fig.4: Microscopic Image of Aluminium for (a) Dry, (b) Semi-Dry and (c) Wet machining

From fig 5 microscopic images of Cast Iron for dry, semi-dry and wet machining are displayed. It is seen that images at all lubrication condition are nearly same but semi-dry has somewhat better surface finish.

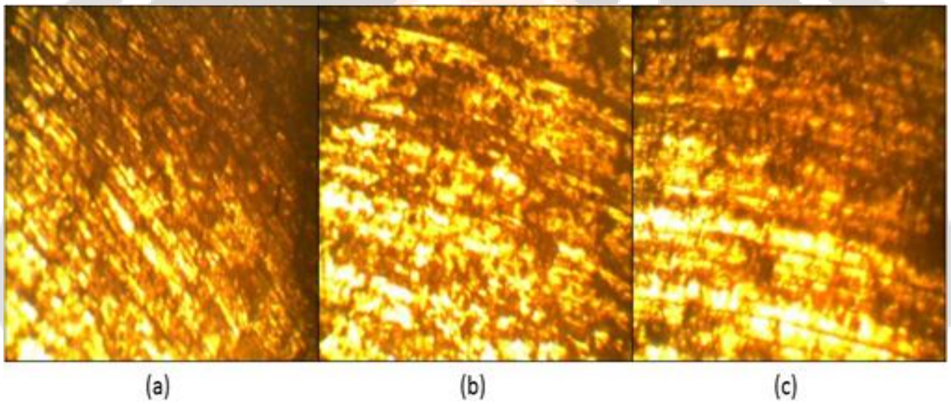
(a) (b) (c)

Fig.5: Microscopic Image of Cast Iron for (a) Dry, (b) Semi-Dry and (c) Wet machining

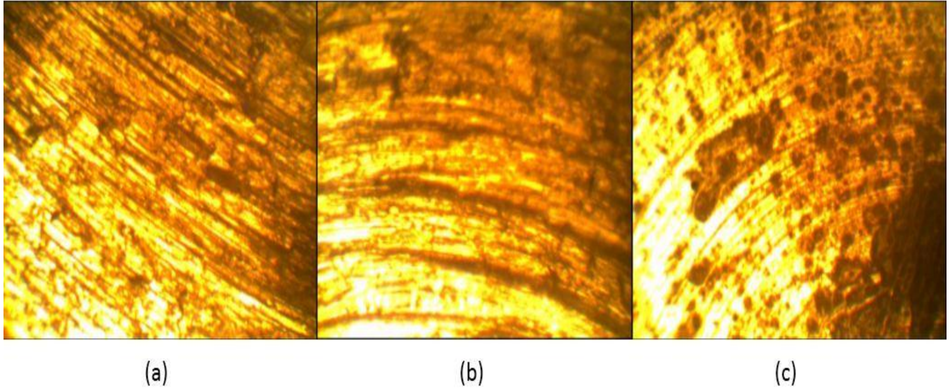
(a) (b) (c)

Fig.6: Microscopic Image of Mild Steel for (a) Dry, (b) Semi-Dry and (c) Wet machining

Figure 6 microscopic images of Mild Steel for dry, semi-dry and wet machining are shown. From fig 6(a) and 6(b) it is clear that surface finish for dry machining is better than that of wet. But semi-dry has somewhat better surface finish. Because comparing with fig 6(b) and 6(c) it is recognizable that semi-dry has less dark spots and dark lines than wet.

5. CONCLUSIONS

In this project the effect of lubrication condition on surface roughness in facing operation was investigated. The experimental results reveal that lubrication condition during facing operation effect roughness of those metal surfaces. And the effective lubrication condition among dry, semi-dry and wet machining for facing operation was identified. Average surface roughness increases with the increase of cutting speed for every lubrication condition (dry, semi-dry and wet machining) and for almost every materials average surface roughness proportionally increases with the increase of cutting speed. With respect to dry and wet machining semi-dry machining exhibits better surface finish for every material. Because it's provides greater smooth contraction between workpiece and cutting tool. For dry, semi-dry and wet machining aluminium shows better surface finish than other materials like cast iron and mild Steel. So, it's made a conclusion that at same type of machining different material shows different surface finish.

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