TO STUDY THE SURFACE ROUGHNESS AND CHIP THICKNESS DURING MACHINING OF MILD STEEL (AISI-1008) USING VEGETABLE BASED OIL AS A CUTTING FLUID

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Abstract*—The objective of the present work is to measure the surface roughness and chip thickness of the mild steel work piece in turning using vegetable oil used as a cutting fluid. In this experimental work we have used single point cutting tool for machining of mild steel (AISI 1008) work piece. The Sunflower oil and Soyabean oil is used as a cutting fluid and also the machining process is done in Dry condition. In this experimental work the tests are performed with different feed rates, cutting speeds and constant depth of cut. Surface roughness and Chip thickness values are measured from these experiments. The High speed steel (H.S.S) tool is used for experimental work. Totally nine experiments are carried out and the results are graphically represented and analyzed. On the basis of data obtained from the experiments performed, the variation of surface roughness and chip thickness is investigated and compared in order to predict the better cutting fluid.

Keywords—Turning, Mild steel (AISI 1008), Sunflower oil, Soyabean oil, Surface roughness, Chip thickness.

I. INTRODUCTION

As the time progresses technological advancement is the key to success. Today's machining industries possess high precision in the work piece geometry, neat finish, elevated production rate, enhanced tool life by reducing the tool wear, economic process inclusive of in house production and environmental impact as well. Amongst steels Mild steel is having a special place in manufacturing sector due to its favorable mechanical properties like, Ductility, machinability and less cost. Premature tool failure and poor surface finish has been experienced during machining due to the temperature at tool – work piece interface. As we know tool wear is proportional to the tool temperature, cutting fluid has been introduced to cut down the regional temperature thus combating the above machining anomalies. It serves as a lubricant also brings down the coefficient of friction to the desired level. So it is imperative to know the science behind the working of different cutting fluids by evaluating the surface condition of the work piece under varied cutting speed.

II. TURNING

Turning is a common machining material removal process in which a single point cutting tool moves axially on the surface of a cylindrical rotating work piece. In general terms reduction in the diameter of a cylindrical object is done by this method. Turning is done to make patterns like steps, taper, chamfer, fillet, contours etc. During the chip formation it slides on the tool rake face, increasing the stresses (normal and shear) and coefficient of friction. In this process mechanical energy is converted into thermal energy thus generating high temperature at the interface (tool work piece) region. To bring down the heated region to a normal level and achieve a decent machined surface. Cutting fluids are required which lubricates the surface and flush away the chips also restricting the friction wear, Flank wear. The work piece will come out to the near dimensional accuracy.

III. CUTTING FLUIDS

As the name suggests fluids which are particularly designed for machining by exhibiting cooling and lubricating properties are termed as cutting fluids. It may be oils, oil-water emulsions, gels, pastes, mists or aerosols, air or gases. These can be extracted from petroleum distillates, animal fats, plants, water, air etc. Cutting fluids are used according to their viscosity, toxicity, flammability, corrosion ability etc. They are also termed as cutting oil, cutting compound, lubricant and coolant depending upon the type. Its application varies with material, environment, weather and other factors.

IV. EXPERIMENTAL SETUP

Various instruments are used for this experiment.

a. Lathe machine
b. Digital vernier caliper
c. Surface profile gauge

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Fig.1 Experimental Setup

V. EXPERIMENTAL PROCEDURE

- Turning operation performed on lathe machine using mild steel as a work piece and high speed steel as cutting tool.
- Machining is done at constant depth of cut and varying feed rate and cutting speed.
- Measuring chip thickness using digital vernier caliper.
- Measuring surface roughness by surface profile gauge.
- Results are evaluated after the plotting different graphs.

VI. RESULT AND DISCUSSIONS

In this experiment the present problem is that to calculate surface roughness and chip thickness using different cutting fluids in turning of mild steel. There are number of experiment was performed to find out the surface roughness of mild steel work piece and chip thickness. The varying parameters such as cutting speed, feed rate and constant depth of cut. By using data different graphs are plotted.

Table I: Investigation details

Tool material	Work piece material	Condition
High speed steel	Mild steel	Dry Condition
		Soyabean oil (Wet)
		Sunflower oil (Wet)

Table II: Machining parameters

Cutting speed(rpm)	Feed rate(mm/min)	Depth of cut(mm)
230	20	3
360	30	3
540	40	3

Table II shows the values of different machining parameters such as cutting speed, feed rate and constant depth of cut. For the measurement of surface roughness and chip thickness mild steel work piece is used for this experiment and the cutting tool is high speed steel tool.

A. Data obtained from Experiments

Results of experiment 1 to 9 provide values of chip thickness and surface roughness in dry and wet machining under different lathe speed and feed rates with constant dept of cut.

Experiment -01

Table III: Chip thickness and Surface roughness in dry machining when cutting speed is minimum and feed rate is also minimum.

1. Coolant Used	Dry Condition
2. Lathe speed	230 RPM
3. Feed rate	20 mm
4. Depth of cut	3mm
5. Chip thickness	0.48mm
6. Surface roughness	49µm

Experiment -02

Table IV: Chip thickness and Surface roughness in dry machining when cutting speed is medium and feed rate is also medium.

1. Coolant Used	Dry Condition
2. Lathe speed	360 RPM
3. Feed rate	30 mm
4. Depth of cut	03 mm
5. Chip thickness	0.5 mm
6. Surface roughness	44 µm

Experiment -03

Table V: Chip thickness and Surface roughness in dry machining when cutting speed is maximum and feed rate is also maximum.

1. Coolant Used	Dry Condition
2. Lathe speed	540 RPM
3. Feed rate	40 mm
4. Depth of cut	03 mm
5. Chip thickness	0.25 mm
6. Surface roughness	39 µm

Experiment -04

Table VI: Chip thickness and Surface roughness in wet machining when cutting speed is minimum and feed rate is also minimum.

1. Coolant Used	Soyabean Oil
2. Lathe speed	230 RPM
3. Feed rate	20 mm
4. Depth of cut	03 mm
5. Chip thickness	0.4 mm
6. Surface roughness	34 µm

Experiment -05

Table VII: Chip thickness and Surface roughness in wet machining when cutting speed is medium and feed rate is also medium.

1. Coolant Used	Soyabean Oil
2. Lathe speed	360 RPM
3. Feed rate	30 mm
4. Depth of cut	03 mm
5. Chip thickness	0.18 mm
6. Surface roughness	29 µm

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Experiment -06

Table VIII: Chip thickness and Surface roughness in wet machining when cutting speed is maximum and feed rate is also maximum.

1. Coolant Used	Soyabean Oil
2. Lathe speed	540 RPM
3. Feed rate	40 mm
4. Depth of cut	03 mm
5. Chip thickness	0.15 mm
6. Surface roughness	24 µm

Experiment -07

Table IX: Chip thickness and Surface roughness in wet machining when cutting speed is minimum and feed rate is also minimum.

1. Coolant Used	Sunflower Oil
2. Lathe speed	230 RPM
3. Feed rate	20 mm
4. Depth of cut	03 mm
5. Chip thickness	0.2 mm
6. Surface roughness	32 µm

Experiment -08

Table X: Chip thickness and Surface roughness in wet machining when cutting speed is medium and feed rate is also medium.

1. Coolant Used	Sunflower Oil
2. Lathe speed	360 RPM
3. Feed rate	30 mm
4. Depth of cut	03 mm
5. Chip thickness	0.15 mm
6. Surface roughness	25 µm

Experiment -09

Table XI: Chip thickness and Surface roughness in wet machining when cutting speed is maximum and feed rate is also maximum.

1. Coolant Used	Sunflower Oil
2. Lathe speed	540 RPM
3. Feed rate	40 mm
4. Depth of cut	03 mm
5. Chip thickness	0.12 mm
6. Surface roughness	20 µm

B. Graphical Analysis

In this section the data obtained from experiments are represented in graphical form in order to understand and investigate the differences among different conditions during machining. The plots are used for the comparative analysis on different conditions during machining i.e. dry condition and wet condition (by using cutting fluids).

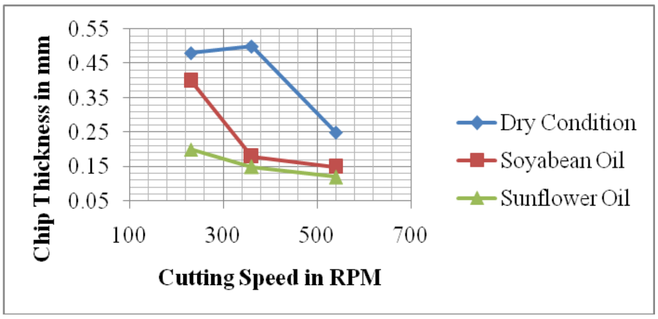

Fig. 2 Variation of chip thickness with cutting speed and constant depth of cut (3mm) in both dry and wet machining.

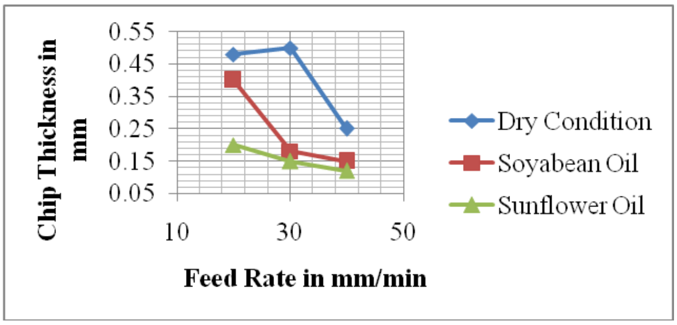

Fig. 3 Variation of chip thickness with feed rate and constant depth of cut (3mm) in both dry and wet machining.

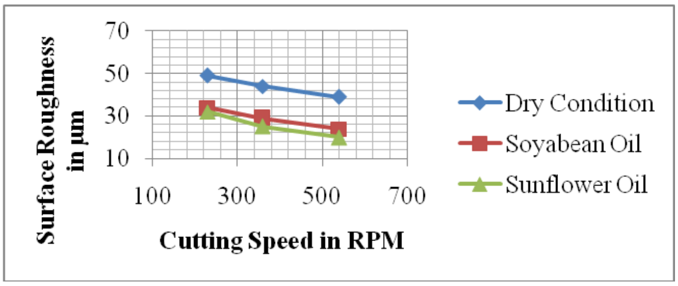

Fig. 4 Variation of surface roughness with cutting speed and constant depth of cut (3mm) in both dry and wet machining.

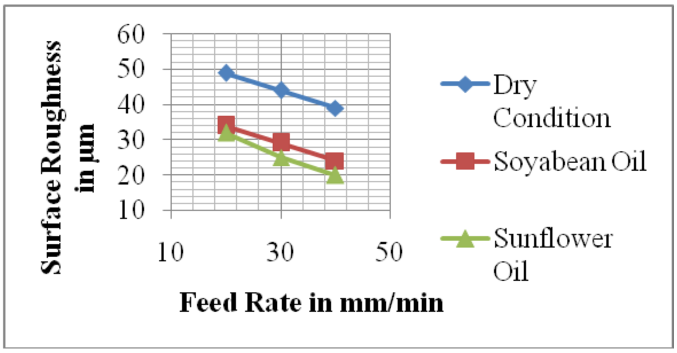

Fig. 5 Variation of surface roughness with feed rate and constant depth of cut (3mm) in both dry and wet machining.

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C. Discussion on Graphical Method

1) Effect of dry and wet machining on chip thickness:

Figure 2 shows the Variation of chip thickness with cutting speed and constant depth of cut (3mm) in both dry and wet machining. It is observed that for dry condition, chip thickness increases from 0.48 to 0.5 mm with the increase in cutting speed from 230 to 350 rpm. Then the chip thickness decreases from 0.5 to 0.25 mm with increase in cutting speed 360 to 540 rpm. It is observed that for wet condition (soyabean oil) , chip thickness decreases from 0.4 to 0.18 mm with the increase in cutting speed from 230 to 360 rpm, Then chip thickness further decreases from 0.18 to 0.15 mm with increase in cutting speed from 360 to 540 rpm. It is observed that for wet condition (sunflower oil) , chip thickness decreases from 0.2 to 0.15 mm with the increase in cutting speed from 230 to 360 rpm, Then chip thickness further decreases from 0.15 to 0.12 mm with increase in cutting speed from 360 to 540 rpm.

It is observed that the curve of dry machining is above that the curves of Soyabean oil and sunflower oil which shows that the chip thickness will be higher in case of dry condition as compared to wet conditions. The curve of Wet condition with Sun flower is below that the other curves which shows that the chip thickness is least in this case. If the chip thickness is less during machining, it is the favorable condition for production process. In context with this fact we can conclude that the Sunflower oil can be preferred over other methods.

Figure 3 shows the Variation of chip thickness with feed rate and constant depth of cut (3mm) in both dry and wet machining. It is observed that for dry condition, chip thickness increases from 0.48 to 0.5 mm with the increase in feed rate from 20 to 30 mm/min. Then the chip thickness decreases from 0.5 to 0.25 mm with increase in feed rate from 30 to 40 mm/min. It is observed that for wet condition (soyabean oil), chip thickness decreases from 0.4 to 0.18 mm with the increase in feed rate from 20 to 30 mm/min, Then chip thickness further decreases from 0.18 to 0.15 mm with increase in feed rate from 30 to 40 mm/min. It is observed that for wet condition (sunflower oil) , chip thickness decreases from 0.2 to 0.15 mm with the increase in feed rate from 20 to 30 mm/min, Then chip thickness further decreases from 0.15 to 0.12 mm with increase in feed rate from 30 to 40 mm/min.

It is observed that the curve of dry machining is above that the curves of Soyabean oil and sunflower oil which shows that the chip thickness will be higher in case of dry condition as compared to wel conditions. The curve of Wet condition with Sun flower is below that the other curves which shows that the chip thickness is least in this case. If the chip thickness is less during machining, it is the favorable condition for production process. In context with this fact we can conclude that the Sunflower oil can be preferred over other methods.

2) Effect of dry and wet machining on surface roughness:

Figure 4 shows the Variation of surface roughness with cutting speed and constant depth of cut (3mm) in both dry and wet machining. It is observed that for dry condition, surface roughness decreases from 49 to 44 µm with the increase in cutting speed from 220 to 360 rpm. Then the surface roughness decreases from 44 to 39 µm with increase in cutting speed from 360 to 540 rpm. It is observed that for wet condition (soyabean oil) , surface roughness decreases from 34 to 30 µm with the increase in cutting speed from 220 to 360 rpm, Then further surface roughness decreases from 30 to 25 µm with increase in cutting speed from 360 to 540 rpm. It is observed that for wet condition (sunflower oil) ,surface roughness decreases from 32 to 25 µm with the increase in cutting speed from 220 to 360 rpm, Then surface roughness further decreases from 25 to 20 µm with increase in cutting speed from 360 to 540 rpm.

It is observed that the curve of dry machining is above that the curves of Soyabean oil and sunflower oil which shows that the surface roughness will be higher in case of dry condition as compared to wet conditions. The curve of Wet condition with Sun flower is below that the other curves which shows that the surface roughness is least in this case. If the surface roughness is less during machining, it is the favorable condition for production process. In context with this fact we can conclude that the Sunflower oil can be preffered over other methods.

Figure 5 shows the Variation of surface roughness with feed rate and constant depth of cut (3mm) in both dry and wet machining. It is observed that for dry condition, surface roughness decreases from 49 to 44 µm with the increase in feed rate from 20 to 30 mm/min. Then the surface roughness decreases from 44 to 39 µm with increase in feed rate from 30 to 40 mm/min. It is observed that for wet condition (soyabean oil) , surface roughness decreases from 34 to 30 µm with the increase in feed rate from 20 to 30 mm/min, Then further surface roughness decreases from 30 to 25 µm with increase in feed rate from 30 to 40 mm/min. It is observed that for wet condition (sunflower oil) ,surface roughness decreases from 32 to 25 µm with the increase in feed rate from 20 to 30 mm/min, Then surface roughness further decreases from 25 to 20 µm with increase in feed rate from 30 to 40 mm/min.

It is observed that the curve of dry machining is above that the curves of Soyabean oil and sunflower oil which shows that the surface roughness will be higher in case of dry condition as compared to wel conditions. The curve of Wet condition with Sun flower is below that the other curves which shows that the surface roughness is least in this case. If the surface roughness is less during machining, it is the favorable condition for production process. In context with this fact we can conclude that the Sunflower oil can be preferred over other methods

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VII. CONCLUSIONS

In the present work, nine experiments are carried out and the results are analyzed. On the basis of data obtained, the variation of surface roughness and chip thickness is investigated and compared and it can be concluded as follows:

- Wet condition i.e. by using cutting fluid during machining is better than dry condition.
- Sunflower oil as a cutting fluid is preferred and more suitable than Soyabean oil for selected range of parameters.

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