

# Development of a New Coconut Oil Based Cutting Fluid for Turning of EN19 Steel

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**ABSTRACT:** The cutting fluids are responsible for reducing heat at tool work interface, reducing the cutting force, easy chip removal, high material removal rate (MRR), lubrication improvement between tool and work piece and thereby increasing the surface finish. Good lubricating capacity, less viscosity, better heat removal rate, high heat conductivity and specific heat are the desired flow and heat transfer parameters of cutting fluids. The development of lubricants like cutting fluids traditionally has mineral oil as base fluid. This fact is related to the technical properties and the reasonable price of mineral oils. Issues of using fluids in machining related to health, environment, and manufacturing cost that need to be solved and options to reduce their use has to be developed. Hence there arises the need for an ecologically benign metal working fluid in machining operations. In this work a coconut oil based cutting fluid is developed with different concentration of oil and water. Different properties of these fluids are also found out. A comparative study of Dry Machining, Wet machining using Coconut oil based fluids and Mineral oil based fluid were conducted by taking EN-19 steel as workpiece material on a CNC Turning Centre.

**KEYWORDS:** Cutting fluids, CNC Turning Centre, Coconut oil based fluid.

## I. INTRODUCTION

The machining processes have an important place in the traditional production industry. Cutting fluids have been used widespread in all machining processes. The positive effect of the use of fluids in metal cutting was first reported in 1894 by F. Taylor, who noticed that by applying large amounts of water in the cutting area, the cutting speed could be increased up to 33% without reducing tool life[1]. Since then, cutting fluids have been developed resulting in an extensive range of products covering most work-piece materials and operations.

The conventional cutting fluids are the mineral oils in two groups - straight oils or water based fluids. The major concerns about the cutting fluids are functional, economic and ecological dimensions[18]. Based on these there are several unsustainable issues. Almost all straight oils are extracted from the crude oil which is decreasing rapidly and in turn increases the price of crude oil and decrease in its availability. The use, disposal etc of conventional cutting fluid will adversely affect the nature very badly. Human health will be negatively affected by direct contact of cutting fluid with skin, which lead to occupational disease and also its contact with eyes will cause damage to the eyes. During machining certain fumes are produced at the contact point, The inhalation of this fume produced causes respiratory diseases. The disposal of this cutting fluid causes air, water and soil pollution. In order to avoid or minimize the use of cutting fluids, several methods were introduced, but make the production costlier. Thus there arise the need of a good alternative cutting fluid which is having the desired properties of the ordinary cutting fluid and which will not produce

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an environmental impact. In this paper the development of a coconut oil based cutting fluid with different concentration of oil and water is described. Different properties of these fluids are also found out. A comparative study of Dry Machining, Wet machining using Coconut oil based fluids and Mineral oil based fluid were conducted by taking EN-19 steel as workpiece material on a CNC Turning Centre.

## II. PREPARATION OF CUTTING FLUID

In order to carry out the project work, literatures related to metal working fluids, vegetable oil based cutting fluids, properties of cutting fluids, turning operation, development of emulsion, surface roughness, tool work interface temperature has been studied. Findings from some of the main literatures are discussed below.

W. Belluco and L. DeChiffre [2] analyzed the performance of six cutting fluids of which five of them are vegetable based cutting fluids. The tool lift, drilling force and chip tangling are taken as testing parameters. The test specimen is AISI316L plates. A load cell is used for measuring cutting force. The chip tangling is also measured after each cycle. Cutting fluid used were mineral oil based commercial oil, vegetable oil based commercial oil, four different combinations of rapeseed oil are ester oil in different form i.e. the meadow form oil, mild duty oil, meadow form and mild duty oil, general purpose oil etc. From the result it was obtained that the tool wear and failure was similar in all six fluids. The result shows that the tool life measure obtained by all five combinations of vegetable oil produced better tool life. But the cutting thrust was almost equal with all six fluids. The corner wear obtained is also lower for the vegetable oil based cutting fluids. The corner wear for mineral oil used is obtained as 300 micrometer whereas the rapeseed as ester oil it is found out 150 micrometer. Overall from the results as study the best performance obtained is about 177% increasing tool life and 7% reduction in thrust force, which was obtained in vegetable oil than the mineral oil. It proves that the vegetable oil based fluid is a good alternative for mineral oil based fluids.

J.F.G. Oliveira and S.M. Alves [3] developed an environmental friendly fluid for CBN grinding. The intention was to develop a fluid based on water. The reaction of the grinding wheel with water was checked experimentally at two conditions - at normal temperature and at 873K. From the experiment it was obtained that the chance for chemical reaction of CBN grinding wheel with water is minimum. For the study new cutting fluid were produced by mixing castor oil (40%), water (35%), bactericide (5%), anti-corrosive agent (15%) and emulsifying agent which is a polyglycol of synthetic ester (5%). The new vegetable oil based grinding fluid showed good results in grinding test similar to one that obtained with neat oil. When new cutting fluid diluted at 45% was used the wheel wear, grinding force and surface roughness were also reduced.

The work done by Salette Martins Alves et al [4] conducted a study for the development of a new concept of grinding fluid to be applied in CBN grinding processes. Water and vegetable oil combination used in production of cutting fluid. The roughness and wheel wear was used to evaluate the grinding operation in order to find out the performance of new cutting fluid. In order to find out best work condition different dilutions were also tested. Materials used in formulation of cutting fluid are sulphonated castor oil 80%, water, bacterial resistance derived from triasin anticorrosive. The wheel wear and work piece roughness were reduced by using new cutting fluid.

Salette Martins Alves and Joao Gomes de Oliveira [6] derived new water based cutting fluid which can meet both the grinding performance and environmental requirements. They selected castor oil as vegetable oil which is highly stable in nature. From the biodegradability test it was found that the fluid is easily biodegradable and the disposal also can be easier. The experiments were conducted on SAE8640 Work piece. The newly selected cutting fluid's properties were compared by taking the cutting oil and semisynthetic cutting fluid as reference fluids. During the experiment several dilutions (35, 45 and 70%) in volume of new cutting fluid were used. The new cutting fluid with concentration of 45% showed highest grinding ratio which is closer to performance of grinding oil. Both roughness average and forces obtained when using new fluid at 45% concentration were similar to grinding oil. The results were comparable with the existing grinding oil.

Kuram et al [10] explained the effects of cutting fluid types and cutting parameter on surface roughness as thrust force. The study was conducted using three different vegetable based cutting fluid and two other commercially available cutting fluids. The three vegetable based fluids are extracted from sunflower oil or raw and refined fluids. These five fluid were used during drilling of AISI304 with high speed E-grade (HSS-E) tool. The spindle speed, feed

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rate and drilling depth are taken as input parameters with two experimental designs. The results obtained during the study showed that the sunflower based cutting fluid offers a lower thrust force and was most effective in reducing roughness average as the spindle speed increases.

Babur Ozcelik et al [13] , done a work in order to optimise the surface roughness in drilling using cutting fluid developed from sunflower oil and other two commercial cutting fluids. The drilling were carried out in AISI304 stain less steel and performance of surface roughness were evaluated using regression S/N ratio and ANOVA. Analysis was carried out to obtain significant parameters influencing surface roughness. The cutting fluid used consists of a vegetable oil as base oil and remaining additives. The additives are added to resist bacterial growth, corrosion, anti-foaming agent and anti-wear agent. The machining were carried out and conducted optimization. The results obtained were showing that the better performance was obtained on vegetable based cutting fluids than semi synthetic and mineral based cutting fluids. The minimum surface roughness value was obtained with vegetable based cutting fluid.

### III. PREPARATION OF CUTTING FLUID

In this work coconut oil is used as the base fluid for the preparation of cutting fluid. The formulation act as an oil in water emulsion. Oleic acid is an unsaturated fatty acid which is used as an emulsifying or solubilizing agent. Besides serving as an agent for improving the lubricity of the cutting fluid, it also acts as friction modifier for lowering the friction coefficient. In water soluble cutting fluids, triethanol amine is used to provide the alkalinity needed to protect against rusting and it acts as an anti-oxidant. It also controls the evaporation rate of water in cutting fluid.

Coconut oil based concentrate was formulated by mixing coconut oil with Oleic acid and Triethanol Amine in the ratio of 2:2:1 respectively. For preparing 1L of oil concentrate 400ml of coconut oil was taken in beaker and 400ml of oleic acid is added slowly. The mixture was stirred thoroughly using a mechanical stirrer upto when a homogenous liquid is formed. Then 200ml of triethanol amine was added to it and stirred well so as to get a homogenous mixture. Thus the oil concentrate is prepared. This homogenous mixture can dissolve in water in all proportions and functions as oil in water emulsion.

Four emulsion samples were formed by varying the concentration of oil as 10%, 20%, 30% and 40%, remaining water. For preparing the emulsion the required quantity of water was taken and the water is stirred using a stirrer so that a vortex was formed. Then the oil was slowly poured into the vortex. The stirring was continued for few minute until we get a homogenous emulsion.

### IV. COMPARISON OF PROPERTIES OF CUTTING FLUID

The selection of cutting fluid is based on some basic properties. The basic properties which determine the selection of cutting fluid are viscosity, thermal conductivity, acidity or alkalinity, relative density etc.

#### A. VISCOSITY

Viscosity is a measure of the resistance of a fluid to deform under shear stress. Viscosity is due to the friction between neighbouring particles in a fluid that are moving at different velocities. The viscosity of the cutting fluids can be measured with the help of Brookfield Rotational Viscometer (model: DV2TLVCJ0) supplied by Brookfield Engineering Laboratories.

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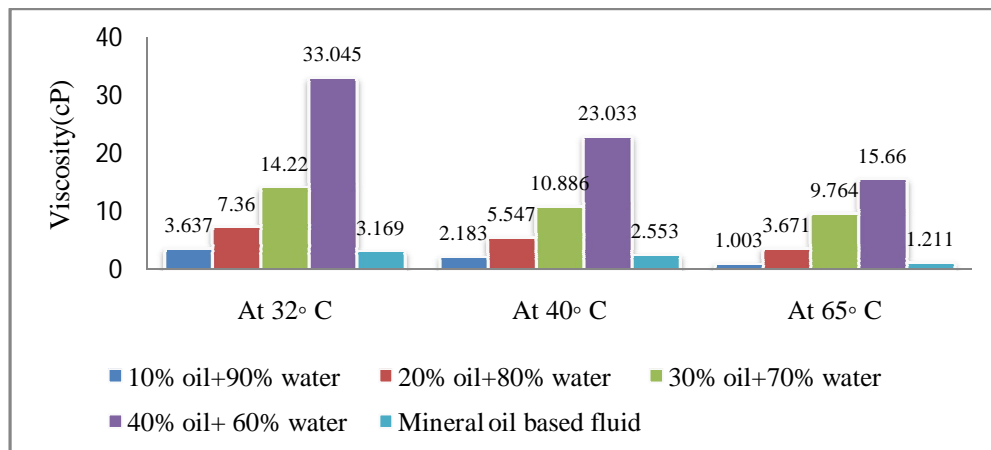


Fig 1: Comparison of Viscosity at Different Temperatures

The Figure 1 shows the variation of viscosity with respect to temperature of different cutting fluids. It is seen that the mineral oil based cutting fluid is having the least value of viscosity at three different temperatures. Coconut oil based cutting fluid with 10% and 20% oil concentration is having comparable viscosity with mineral oil based cutting fluid. But other two combination of coconut oil based cutting fluid is having higher viscosity when compared with mineral oil based cutting fluid. The viscosity of cutting fluid increases the lubrication effect but it reduces the flowability of cutting fluid. So a moderate viscosity is desirable for a cutting fluid. The viscosity of all fluids decreases with increase in temperature.

## B. THERMAL CONDUCTIVITY

Thermal conduction is a very important and a major topic in the study of heat transfer. Conduction is the transfer of energy from energetic particles of a substance to the adjacent less energetic ones as a result of interactions between the particles. The thermal conductivity of the prepared cutting fluid were measured using a KD2 PRO thermal conductivity probe (Decagon Devices Inc., US). This instrument works on the classical transient hot wire method which is the most widely used technique in measurement of thermal conductivity of liquids in general and cutting fluid in particular.

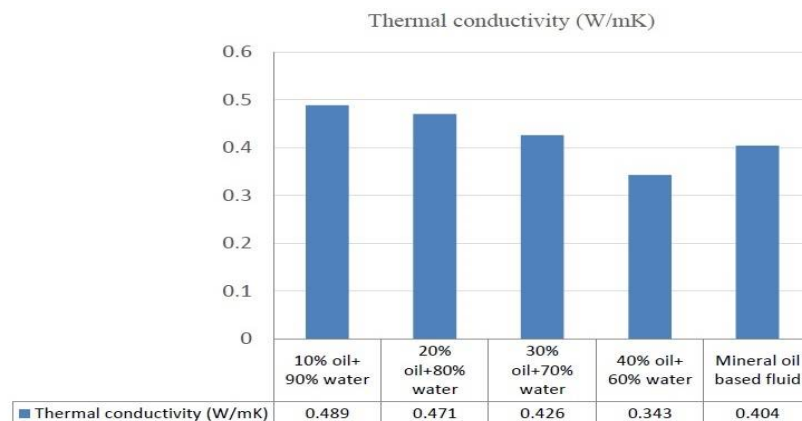


Fig 2: Thermal Conductivity of fluids

The thermal conductivity of cutting fluids considered are shown in the figure 2. Among these cutting fluids the coconut oil based cutting fluid with 10% oil concentration gives maximum thermal conductivity. The thermal conductivity of

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coconut oil based cutting fluid with 40% oil concentration is having least thermal conductivity which is also less than mineral oil based cutting fluid. All other cutting fluids developed from coconut oil showed more thermal conductivity than mineral oil based cutting fluid. So the cooling effect that can be produced by these fluid is more than that of mineral oil based cutting fluid. As the water content in emulsion increases the thermal conductivity of emulsion also increases which can be seen from the figure.

### C. RELATIVE DENSITY

Relative density is the ratio of the density of liquid to the density of water at same condition of temperature and pressure. The density of liquid is required to calculate flow rates and for the conversion of kinematic viscosity to dynamic viscosity. A good cutting fluid should always possess good flow ability as well as good lubricating property. For this the relative density should not be so high or so low. Most mineral oils have the viscosity in the range between 0.85 to 0.95.

In order to measure the relative density the weight of 25ml of water is measured using a digital weight meter then the weight of 25ml of required sample is also taken. Then by taking the ratio between weight of fluid to weight of water the relative density of required fluid sample is obtained.

$$RELATIVE\ DENSITY = \frac{WEIGHT\ OF\ 25ml\ OF\ TEST\ FLUID}{WEIGHT\ OF\ 25ml\ OF\ WATER}$$

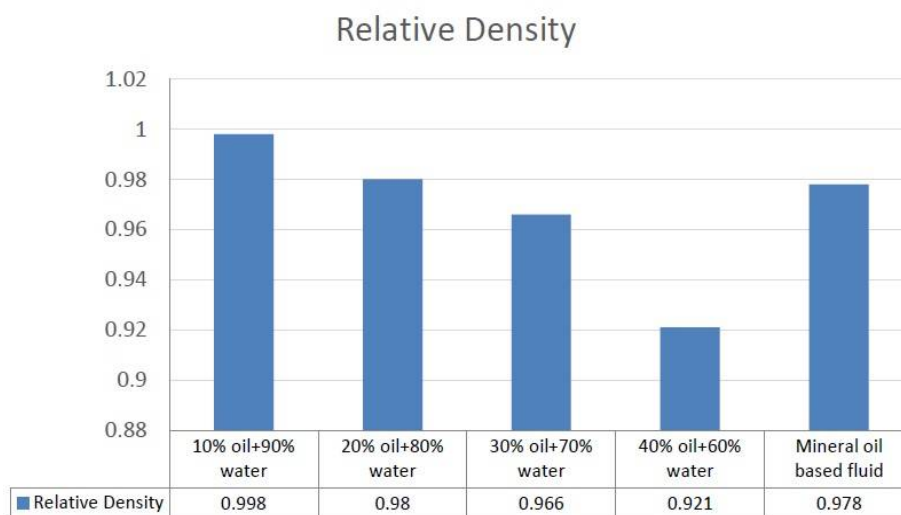


Fig 3: Relative density of fluids

The relative density of different cutting fluid are shown in the figure 3. The relative density of coconut oil based fluid having 10% oil concentration is almost equal to 1. Coconut oil based cutting fluid with 10% and 20% oil concentration is having more relative density than mineral oil based cutting fluid. Other two fluids are having lesser relative density. The increase in oil content decreases the relative density of emulsion.

### D. ACIDITY AND ALKALINITY

The nature of cutting fluid in case of acidity also determines the selection of cutting fluid. The acidity or alkalinity of cutting fluid can be determined by using a pH meter. The pH scale shows a fluid's acidity or alkalinity. The fluid

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having a value less than 7 during pH test is acidic in nature and pH value greater than seven is basic in nature. Pure water is having a pH value of seven.

In case of cutting fluid the fluid is commonly made basic. The acidity of cutting fluid will produce a chance of combustion during machining. So cutting fluids are commonly basic in nature. Basic nature of the cutting fluid also protects the work piece from corrosion or oxidation and it helps in stabilizing the emulsion. The acidity or alkalinity of the fluid samples are measured by using a digital pH meter. A digital pH meter is a scientific instrument that measures the hydrogen-ion concentration (or pH) in a solution, indicating its acidity or alkalinity. The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode and converts this electrical potential to pH of fluid.

**pH OF CUTTING FLUIDS**

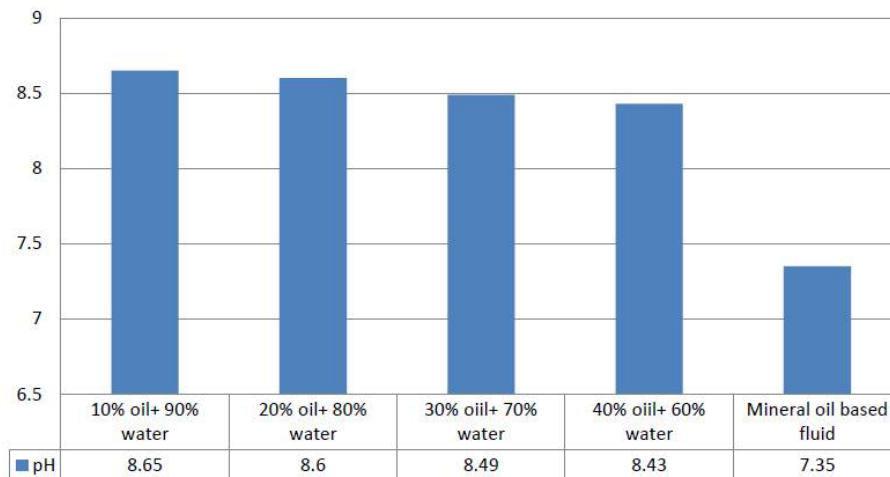


Fig 4: pH of cutting fluids

## V. EXPERIMENTAL DETAILS

EN19 steel was selected as the work piece material which is a high quality low alloy steel. This grade offers good ductility and shock resisting properties combined with resistance to wear. EN19 is usually available as untreated but it can be heat treated to required hardness for different applications. EN19 in its heat treated forms possesses good homogenous metallurgical structures, giving consistent machining properties.

The work piece used for the study is EN19 steel equivalent to AISI 4140 rod with 30 mm diameter and 60 mm length and there is a total number of 54 work pieces having the same dimension. For this an EN 19 steel rod having 32 mm diameter and 4 meter long is purchased and cut it into required length after correcting the diameter to 30 mm.

The cutting tools used are coated carbide inserts of grade H13A made by SANDVIK Coromant. The inserts used are of CNMG type. The selection of cutting tool is done according to the range of control factors (cutting speed, speed and depth of cut) and the hardness of the material being cut. The tool is selected using the information obtained from tool manufacturer's catalogue.

Conventional machines are replaced by the Computer Numeric Controlled (CNC) machines due to their inherent advantages. High accuracy, flexibility, machining of complex components and reduced production time are the main advantages of CNC machines. In the present work the turning process is carried out on a two axis CNC machine. The different sets turning experiments are performed on a two axis CNC lathe.



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Fig 5: Two axis CNC lathe

Sl no.	SPEED(mm/min)	FEED(mm/rev)
1	120	0.1
2	120	0.15
3	120	0.2
4	150	0.1
5	150	0.15
6	150	0.2
7	180	0.1
8	180	0.15
9	180	0.2

Table 1: Combination of feed and speed

Combination of feed and speed selected for the study is shown in Table 1. Each combination is machined in 6 cutting condition ie, Dry condition, machining with mineral oil based cutting fluid, machining with Coconut oil based cutting fluids having 10%,20%,30% and 40% of oil concentration. The machining program for turning is entered according to the values provided in Table 1. Turning is carried out for a 20mm length which is just enough surface area to allow for cutting stabilization and subsequent surface roughness measurement. After machining the work piece is given to the inspection section of surface roughness. The tool-work piece interface temperature is measured using infrared thermometer.

## VI. INSPECTION AND DATA COLLECTION

The machined work piece is inspected for surface roughness after every machining process. The machined surface was measured at three different positions and the average (Ra) values are taken using a Mitutoyo SURFTEST SJ-410 surface roughness meter, which has diamond stylus tip with accuracy of 0.005 $\mu$ m and resolution of 0.05  $\mu$ m and having a maximum measuring range of 300  $\mu$ m.

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Fig 6: Roughness Tester (SJ-410)



Fig 7: Temperature Measurement

During machining, the consumed power is largely converted into heat resulting high cutting temperature near the cutting edge of the tool. The amount of heat generated varies with the type of material being machined and machining parameters. The surface temperature of the machined samples were measured by using infrared thermometer (make: HTC MTX-2) having temperature range of -30°C to 550°C and with optical resolution technique. Three different readings are taken from the cutting zone of the workpiece and the average value is taken as workpiece surface temperature. The data collected are shown in the table 2.

Trial No.	Speed m/min	Feed mm/rev	Type of oil	Roughness average(Ra)	Temperature
				μm	°c
1	120	0.1	DRY	1.675	58
2	120	0.1	Mineral oil	0.862	37.6
3	120	0.1	10% oil	0.902	33.4
4	120	0.1	20% oil	0.856	34
5	120	0.1	30% oil	0.864	38.5
6	120	0.1	40% oil	0.927	42.6
7	120	0.15	DRY	1.873	60.2
8	120	0.15	Mineral oil	1.035	36.8
9	120	0.15	10% oil	1.139	32.4
10	120	0.15	20% oil	0.964	33.2
11	120	0.15	30% oil	0.974	39.7
12	120	0.15	40% oil	0.985	45.4
13	120	0.2	DRY	2.047	56.7
14	120	0.2	Mineral oil	0.986	34.5
15	120	0.2	10% oil	1.17	31.9
16	120	0.2	20% oil	0.979	32.4
17	120	0.2	30% oil	0.996	38.7
18	120	0.2	40% oil	1.112	44.2
19	150	0.1	DRY	1.495	55.8
20	150	0.1	Mineral oil	0.941	36.7
21	150	0.1	10% oil	0.905	32.8
22	150	0.1	20% oil	0.85	33.1
23	150	0.1	30% oil	0.856	39.6
24	150	0.1	40% oil	0.915	46.3
25	150	0.15	DRY	1.675	56
26	150	0.15	Mineral oil	0.93	33.9



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27	150	0.15	10% oil	0.981	31.2
28	150	0.15	20% oil	0.938	31.4
29	150	0.15	30% oil	0.954	37.7
30	150	0.15	40% oil	0.977	48.2
31	150	0.2	DRY	1.914	58
32	150	0.2	Mineral oil	0.983	32.2
33	150	0.2	10% oil	1.21	30.4
34	150	0.2	20% oil	0.969	31.4
35	150	0.2	30% oil	0.978	39.6
36	150	0.2	40% oil	1.1	47.4
37	180	0.1	DRY	1.414	60.5
38	180	0.1	Mineral oil	0.829	33.5
39	180	0.1	10% oil	0.894	32.5
40	180	0.1	20% oil	0.839	33
41	180	0.1	30% oil	0.844	38.4
42	180	0.1	40% oil	0.908	47.4
43	180	0.15	DRY	1.597	59.5
44	180	0.15	Mineral oil	0.962	35.6
45	180	0.15	10% oil	1.079	31.2
46	180	0.15	20% oil	0.953	32
47	180	0.15	30% oil	0.962	39.2
48	180	0.15	40% oil	0.984	45.2
49	180	0.2	DRY	1.958	57.9
50	180	0.2	Mineral oil	1.168	34
51	180	0.2	10% oil	1.235	31.1
52	180	0.2	20% oil	0.981	31.9
53	180	0.2	30% oil	0.993	38.9
54	180	0.2	40% oil	1.125	46.9

Table 2: Data Collection

## VII. RESULTS AND DISCUSSIONS

The datas collected were analysed and the following graphs were plotted using the MS EXCEL software.

- Comparison of Ra with respect to speed
- Comparison of Ra with respect to feed
- Comparison of temperature with respect to speed
- Comparison of temperature with respect to feed

### a) COMPARISON OF Ra WITH RESPECT TO SPEED

Figure 8 shows variation of roughness average with speed for different cutting fluids for 3 different feed rates. From the curves it is clear that surface roughness produced in dry machining is more than that of other cutting fluids in all combination of parameters. The coconut oil based cutting fluid with 20% and 30% oil concentration showed better result than mineral oil based cutting fluid and other 2 two type of coconut oil based cutting fluid throughout the experiment. The coconut oil based cutting fluid with 10% oil concentration produces less lubricating effect since it is having less oil content and also it is having lesser viscosity than mineral oil based cutting fluid. But in case of coconut oil based cutting fluid with 40% oil concentration it is having high value of viscosity so the flowability of fluid is less thus the roughness produced will be high. From the graphs it is clear that as the speed of cutting increases the Ra is decreasing. High speed is desirable for better surface finish.

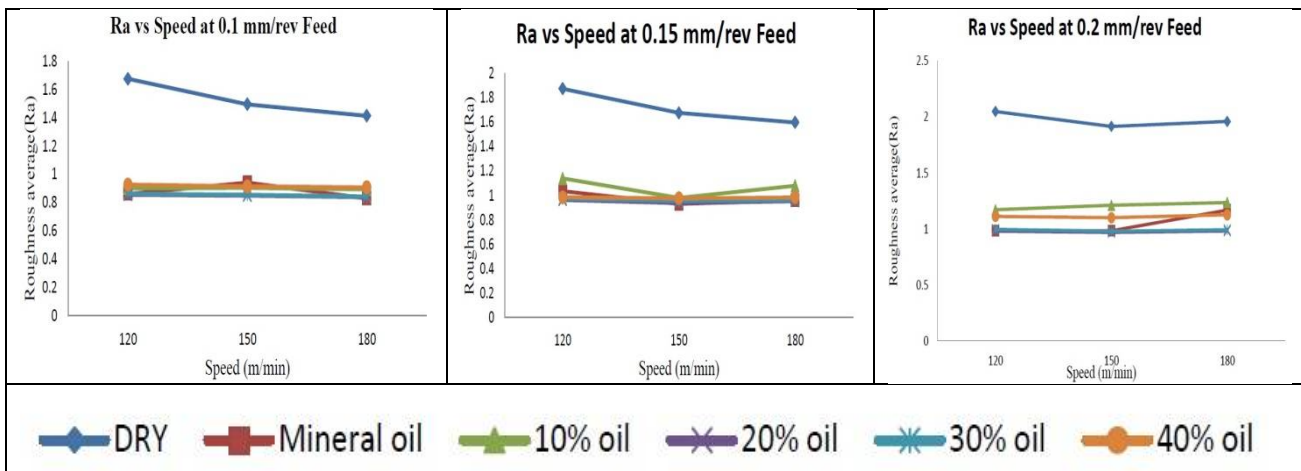


Fig 8: Comparison of Ra with respect to Speed

**b) COMPARISON OF Ra WITH RESPECT TO FEED**

Figure 9 shows variation of roughness average with feed for different cutting fluid at various speed levels. It can be seen that the surface roughness value is more in dry machining condition during all the cutting condition. As seen in previous case the coconut oil based cutting fluid with 20% and 30% oil concentration shows minimum surface roughness than other variety of cutting fluid including mineral oil based cutting fluid. The coconut oil based cutting fluid with 10% and 40% oil concentration shows higher value of roughness than mineral oil based cutting fluid.

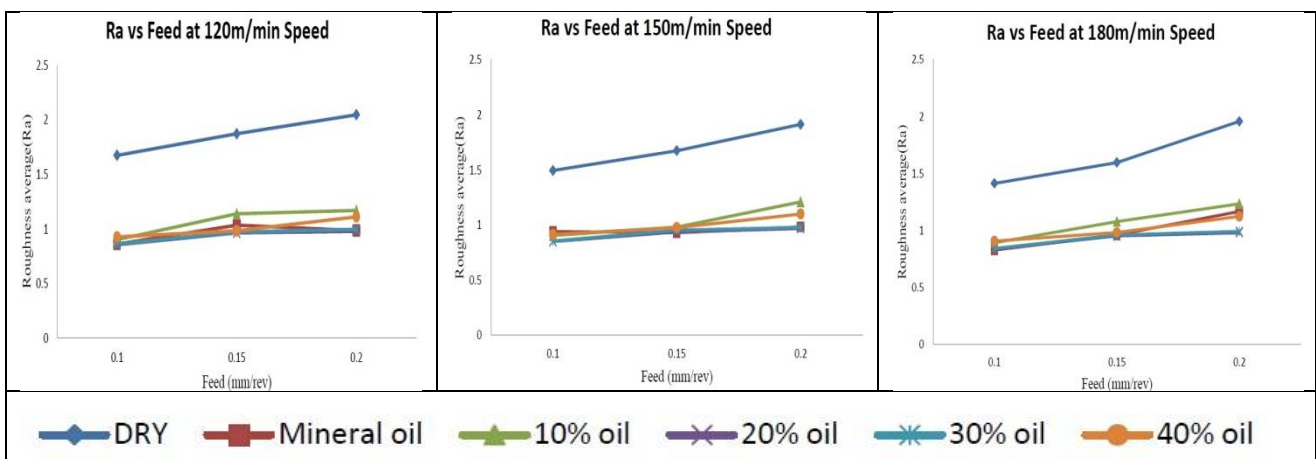


Fig 9: Comparison of Ra with respect to Feed

**c) COMPARISON OF TEMPERATURE WITH RESPECT TO SPEED**

The variation of temperature at tool workpiece interface with respect to speed during machining using different cutting fluid at 3 levels of feed are shown in the fig 10. It can be clearly seen that the machining in dry condition produced maximum temperature. The tool work piece interface temperature is maximum in dry condition; coconut oil based cutting fluid having 40% oil concentration comes next, then comes the coconut oil based cutting fluid with 30% oil concentration after that mineral oil based fluid and the minimum temperature at tool work interface is observed in machining using coconut oil based cutting fluid having 10% and 20% oil concentration. The thermal conductivity of

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coconut oil based cutting fluid with 10% and 20% oil concentration is higher than mineral oil based cutting fluid which helps in easy heat removal and helps in producing superior cooling effect.

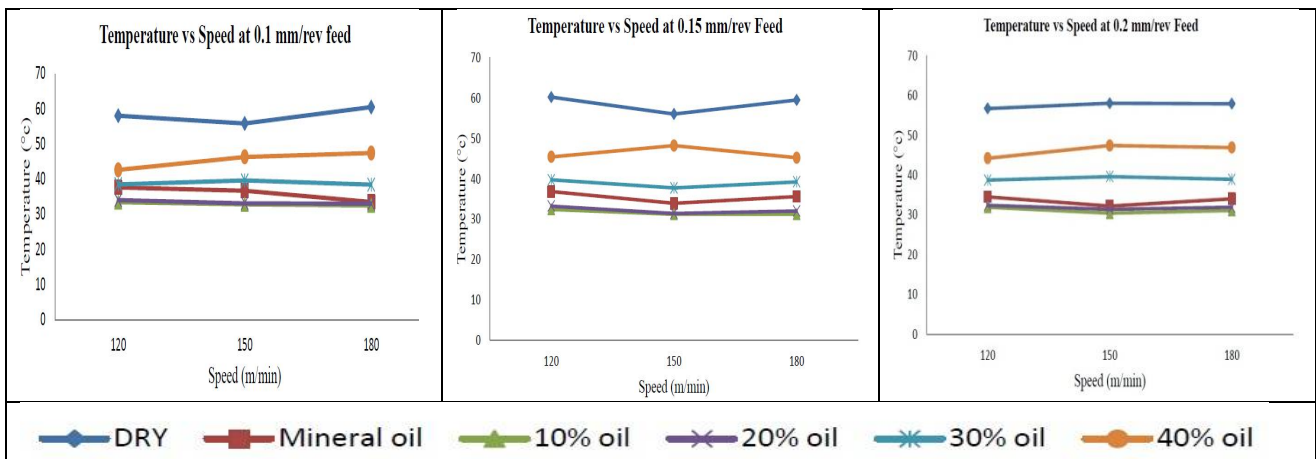


Fig 10 Comparison of Temperature with respect to Speed

## d) COMPARISON OF TEMPERATURE WITH RESPECT TO FEED

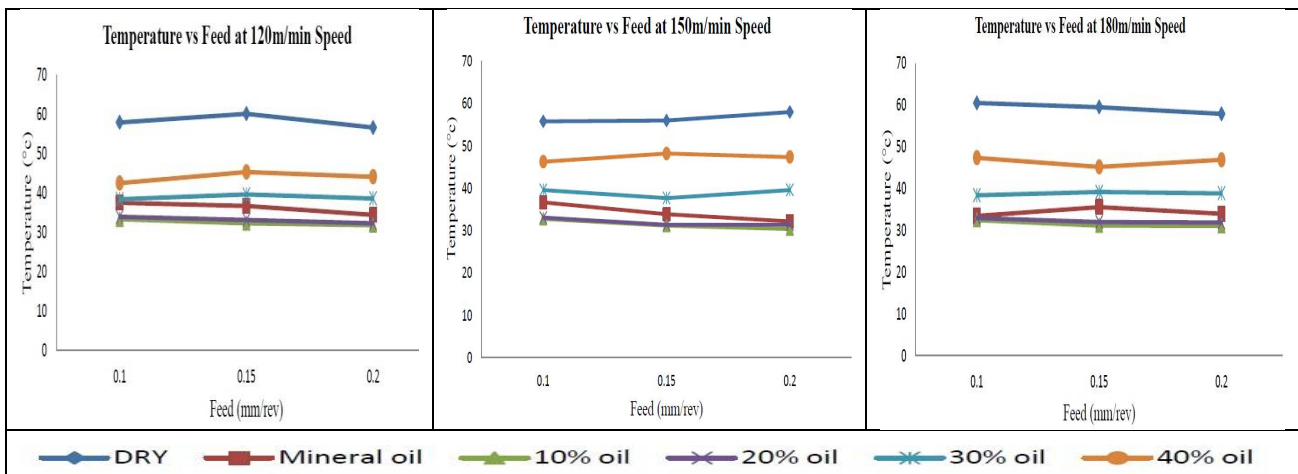


Fig 11: Comparison of Temperature with respect to Feed

The fig 11 shows the variation of temperature at tool work interface with feed at 3 different speed levels. The same effect that has been seen in previous discussion can be seen in this comparison also. The temperature produced at tool work interface is maximum in dry condition and minimum for coconut oil based cutting fluid with 10% and 20% oil concentration.

During machining more importance is given for obtaining required surface finish and minimizing the surface temperature in order to reduce the tool wear. Cutting fluids are used in order to improve the surface finish and to reduce the tool wear. Considering these conditions the cutting fluid should help to improve the surface finish and should reduce the temperature at tool work interface. From this study among the new coconut oil based cutting fluid developed the fluid with oil concentration of 20% produced better performance both in case of improving surface finish as well

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reducing the temperature at tool work interface. In almost all condition this fluid performed superior to mineral oil based cutting fluid.

## VIII. CONCLUSION

Coconut oil based emulsion prepared by mixing oil and water with the help of a suitable emulsifying agent the main properties of the cutting fluid like viscosity, thermal conductivity, relative density and pH is also measured for each concentration of coconut oil in water emulsion and is also compared with commonly used mineral oil based cutting fluid.

The experimental study was carried out on a CNC lathe for turning operation of EN 19 Steel. Cutting speed, feed rate and type of cutting fluid are as selected as process parameters by keeping constant depth of cut. Surface finish and tool work interface temperature were selected as responses. Fifty four experiments were carried out to collect the data for study and required graph were plotted using MS Excel software.

Study shows that the coconut oil based cutting fluid with 20% oil concentration shows better performance than other fluid during machining. All the developed cutting fluid except fluid with the coconut oil based cutting fluid with 40% oil concentration shows a comparable or better performance with mineral oil based cutting fluid.. Machining using the coconut oil based cutting fluid with 20% and 30% oil concentrations gave better surface finish than mineral oil based cutting fluid.

Machining using the coconut oil based cutting fluid with cutting fluid with 10% and 20% oil concentration showed lesser value of temperature at tool work interface. The viscosity values of the coconut oil based cutting fluid with cutting fluid with 10% and 20% oil concentrations gives comparable result with mineral based cutting fluid. But the value of other two concentrations was more than that of mineral oil based cutting fluid. Since concentration of oil in emulsion increases the viscosity of emulsion also increases. The thermal conductivity of the coconut oil based cutting fluid with cutting fluid with 10% oil concentration is superior to all other fluids. The thermal conductivity of fluid increases with decrease in oil concentration in an emulsion. All the cutting fluid developed is basic in nature which a desirable property of cutting fluid.

Overall cutting fluid with 20% oil concentration is having better performance than all other varieties. Since both surface roughness and tool work interface is minimum. The reduced surface roughness and tool wear is due to the combined effect of both viscosity and thermal conductivity. As the oil content in emulsion increases viscosity increases and hence the lubrication increases but the thermal conductivity decreases. The water content in emulsion enhances thermal conductivity. Considering these facts in both aspects cutting fluid with 20% oil concentration shows better results. So the coconut oil based cutting fluid can be utilized as a suitable and possible alternative for mineral oil based cutting fluid considering the environmental issues and wastage accumulation.

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