Effect of Cashew Nut Shell Oil as Cutting Fluid in Turning Operation

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***Abstract*: Cutting fluids are widely used to obtain longer tool life and better surface finish of the component. In current situation petroleum or mineral oils are used as an alternative cutting fluid in machining process. In this paper bio oil is prepared from the cashew nut shell and physiochemical properties are tested. The bio oil is blended with existing 20w40 oil and blend sample properties are determined. The blended oil were used as cutting fluid in lathe. The properties like viscosity, fire point and flash point for this bio oil shows that this oil is suitable for cutting fluid. After machining surface roughness is tested by using surface roughness tester SJ-210. The result of surface roughness is compared with existing cutting fluid. An experimental result shows that the prepared oil has excellent surface finish. Hence the paper proposes an alternative cutting fluid.**

IndexTerms*: *Cutting Fluids, Surface Finish, Machining Process, Physiochemical Properties, Surface Roughness.

I. INTRODUCTION

The development of lubricants like, cutting fluids was traditionally based on mineral oil as a base Fluid. This fact is related to the technical properties and the reasonable price of mineral oils. Cutting fluids are used widely to reduce the negative effects of the heat and friction on both tool and workpiece. The cutting fluids generally produces three positive effects in the process such as heat removal, lubrication on the chip–tool interface and chip removal. Issues of using fluids in machining related to environment, health, and manufacturing cost that need to be solved and options to reduce their use has to be accomplished. Hence there arises the need for an ecologically benign metal working fluid in machining operations. A comparative study of Dry Machining and Wet Machining where rice bran oil and coolant oil (Shell Tellus-40) is used as the cutting fluid serves as the scope of this study. The results obtained with conventional flood cooling method are compared with that of Dry cutting. The experiment is carried out in a CNC lathe for turning operation on plain carbon steels EN8 and EN9 for surface roughness and tool life by varying parameter like Cutting speed and Feed keeping depth of cut constant [1].

The selection of proper machining parameters with proper cutting fluids will increase the tool life and will result in good surface finish on the material. Hence the temperature of tool tip -work piece interface was examined at different spindle speed, feed rate and depth of cut with soluble oil and palm oil as cutting fluid [2]. The increasing attention to the environmental and health impacts of industrial activities by governmental regulations and by the growing awareness level in the society is forcing industrialists to reduce the use of mineral oil based metal working fluids as cutting fluid. Cutting fluids have been used extensively in metal cutting operations for the last 200 years. In the beginning, cutting fluids consisted of simple oils applied with brushes to lubricate and cool the machine tool. As cutting operations became more severe, cutting fluid formulations became more complex. There are now several types of cutting fluids in the market and the most common types can be broadly categorized as cutting oils or water-miscible fluids [3].

Mild steel has been used in large quantities for years because of desirable properties as good ductility, good machinability and low cost. During machining, the operators encounter certain difficulties such as premature tool failure and poor surface finish due to high temperature at tool– work piece interface. Due to the fact that, higher tool temperature, the faster the wear, the use of cutting fluids in machining processes has, as its main goal, the reduction of the cutting region temperature, either through lubrication and reduction of friction wear, and through a combination of these functions [4].

In this paper an attempt is made to determine the surface roughness of the workpiece by using prepared cutting fluid at different depth of cut at constant rpm. The roughness of the workpiece was analyzed with surface roughness tester. The existing and blend samples are used as cutting fluid in lathe.

II. OIL PREPARATION

A huge amount of cashew nut shell is collected and exposed in sunlight to remove moisture content. After sun dried, the shells were fed in to mechanical expeller which creates high pressure for extracting oil from cashew nut shell. Oil is extracted from mechanical expeller by mechanical pressing method. It is also known as mechanical crushing method. The raw shells are squeezed under high pressure. First the raw shells are feeded in the top side of the expeller. A chain like conveyor system moves the raw shells for crushing inside the expeller machine. As a raw material is pressed, friction causes heat also, the material can exceed upto 48 to 58 ºC. When oil was exerted, solid cake like structure remain in the unit which was removed after oil extraction by dismantling the expeller. The exerted oil has some impurities and solid particles it is removed by using filter. The total cashew nut shell collected is 10kg, for that 10kg the oil extracted is 2.1 litres. Which shows the oil yield of 21%.

Fig.1 Mechanical Expeller

Blending of Oils

The bio cashew nut shell oil is blended with existing SAE 20W40 oil with the help of magnetic stirrer. The four blend proportions are made 10%, 20%, 30% and 40% that is also would be called as B10, B20, B30 and B40. The oil is heated for 50º and blended in magnetic stirrer for 15 minutes. While blending no need of additive is added to mix bio oil with existing lube oil because the density difference for bio oil and 20W40 oil is 0.02, So the bio oil is easily mixed with 20W10 oil easily. The properties needed for lubricant is determined for exiting oils, bio oils and blend samples and also tabulated below.

Table 1 Comparison of Lubricant Properties

PHYSICO CHEMICAL ANALYSIS							
PARAMETER	**BIO Oil**	**Existing Cutting Fluid**	**20W40**	**B10**	**B20**	**B30**	**B40**
Density (gm/ml)	0.921	0.82	0.89	0.68	0.73	0.81	0.92
Flash point (ºC)	248	237	236	240	245	246	234
Fire point (ºC)	250	240	238	244	248	250	238
Viscosity at 40ºC (cst)	135	125	124	117	108	105	120
Viscosity at 100ºC (cst)	18	16	15	17.8	14.8	15.2	16.5

III. EXPERIMENTAL PROCEDURES

Workpiece specifications

The material chosen in this work in mild steel. Mild steel of diameter of 32mm and length of 110mm. Turning operation is done here with this workpiece. Mild steel is cheapest and easily available. So mild steel is selected.

Cutting tool

HSS – high speed steel is capable of cutting the metal at higher rate and retain its hardness even when the point of tool is heated. So this high speed tool is used here.

Experimental Description

The machining process was conducted on centre lathe light duty machine. It was powered by 1hp motor. The maximum chuck diameter is 160mm and speed range varying from 50 to 450rpm. Experiments were conducted for turning operation under varying depth of cut and with different cutting fluids. Rpm is made constant 340. Three depth cut is given 1mm, 1.25mm and 1.5mm. Turning is done for two sides of the workpiece with different samples of oils. The cutting fluid is changed for each side of workpiece. High speed steel is mounted on tool post of the lathe. Same time workpiece is fixed in the three jaw chuck centrally. The cutting fluids used are Existing coolant, 20W40 oil, B10, B20, B30 and B40. The oil samples are used under three depth of cut. Figure 2 shows the chuck holding the workpiece before turning operation, Figure 3 and 4 shows the turning operation on different depth of cuts. Figure 5 shows the workpiece after turning process.

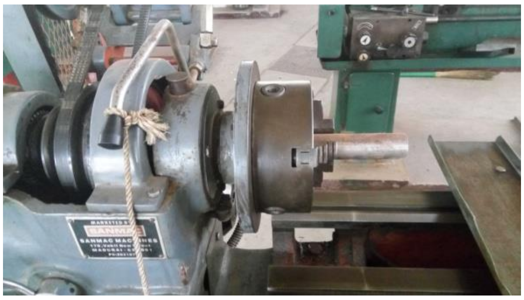

Fig 2. Chuck holding the workpiece

Fig 3. Turning process for 1.25mm

Fig 4. Turning process for 1.5mm depth of cut

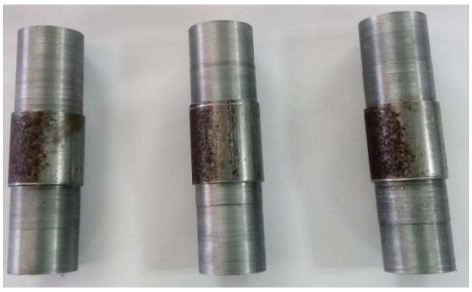

Fig 5. Workpiece after machining

Surface roughness test

Surface roughness test is used to find out the surface roughness of machining workpieces or any other material surfaces. Detector and drive is the important component of surface roughness meter. It shows how much the surface is smooth. Its unit is µm. Surface roughness tester is made by MITUTOYO company, Model – SJ210. The readings are measured under roughness standard JIS1994.

Fig 6. Surface roughness tester

Procedure:

- Place the work piece in the V – Block.
- Calibrate the instrument until reading shows 2.97 µm.
- First the device should be cooled in air conditioner for best accurate values.
- With the help of vernier scale height is adjusted of the detector, by adjusting the height of the drive with probe is allowed to touch the surface of the workpiece.
- Check the split level in glass, It should be positioned centered.
- The surface tester displays shows the reading as the probe senses.
- When the instrument is calibrated, start the testing by pressing start button is surface roughness tester.
- The drive moves left and right movement to measure the surface roughness.
- The readings are displayed on the device after detecting.
- Rotate the work pieces and measure the roughness for trial values.
- Three to five trial values are taken and then calculate the mean value.
- Follow the procedure for all samples.

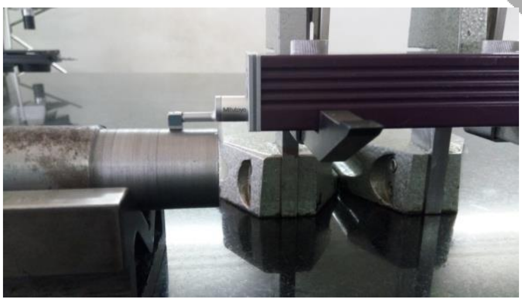

Fig 7. Probe measuring the workpiece

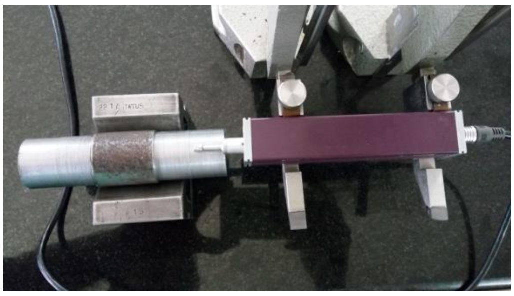

Fig 8. probe measuring the roughness

Fig 9. Display while detecting

Fig 10. Detected roughness value

Table 2 Roughness value

Depth of cut (mm)	Oil sample	Trial 1 (µm)	Trail 2 (µm)	Trial 3 (µm)	Average value (µm)
1.5	**Existing Cutting Fluid**	5.682	5.129	5.289	5.366
1.25		4.321	4.721	4.936	4.659
1		4.125	3.971	4.017	4.037
1.5	**20W40**	9.620	9.025	9.445	9.363
1.25		7.636	8.141	7.604	7.793
1		6.113	6.781	6.287	6.393
1.5	**B10**	8.520	9.175	8.968	8.887
1.25		6.305	5.963	6.221	6.163
1		5.317	5.001	4.971	5.096
1.5	**B20**	6.106	6.100	6.171	6.125
1.25		5.561	5.177	5.581	5.439
1		4.871	4.684	4.331	4.608
1.5	**B30**	5.958	5.877	5.538	5.791
1.25		4.884	4.875	5.115	4.958
1		4.017	4.378	3.987	4.127
1.5	**B40**	5.546	5.536	5.471	5.517
1.25		3.474	3.321	3.567	3.454
1		2.971	3.114	2.194	2.759

By using the formula average value is found with trial values.

$$\text{Average value} = \frac{\text{Trial 1} + \text{Trail 2} + \text{Trail 3}}{3}$$

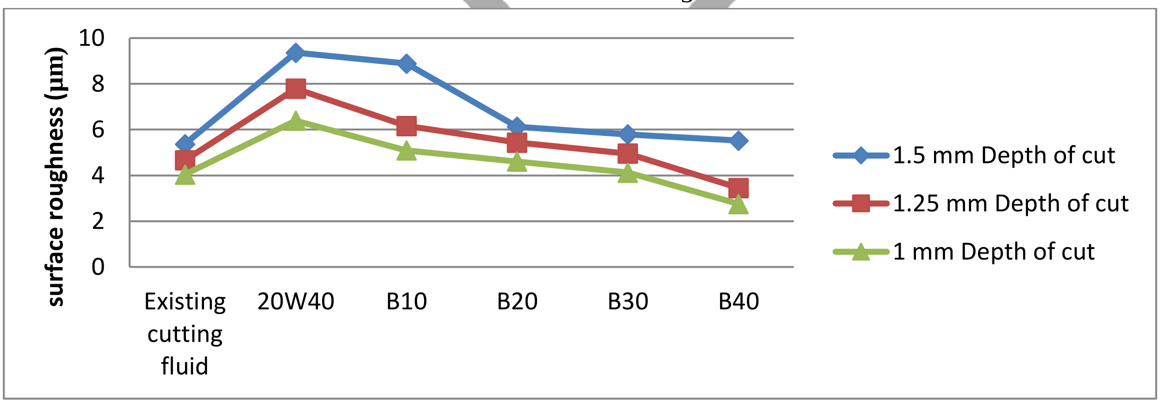

Fig 11. Surface roughness for different samples

IV. CONCLUSION

From the experiment, it is clear that the cutting fluids have impact over machining parameters. Depth of cut and cutting fluids were varied and keeping the rpm constant. Readings indicates B40 sample have good surface finish as per surface roughness test. This study is aimed to derive an comparison between blended cashew nut shell oil and existing coolant. The effects of various samples of cutting fluids on machining process are identified experimentally and the values are tabulated and are plotted in graph, the graph clearly shows that B40 acts good and suitable for cutting fluid. This cashew nut shell oil is available at low cost comparing existing cutting fluids and coolant. As per viscosity test the bio oil, B30 and B40 have good viscosity than existing cutting fluid and existing engine oil 20W40 working at high temperature at 100 ºC. This bio oil is well much suitable and works best even at high temperature.

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