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Experimental Investigation of Coconut Based Nano Cutting Fluid on CNC Turning Operation

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Abstract: The surface roughness is paying a very dominant role in manufacturing industries. It is one of the parameters that cannot be avoided in machining process. Investigation was done on turning alloy steel EN19 with TIC-coated carbide insert in a CNC lathe. During machining on titanium, the high cutting temperature found, because of that friction in tool causes, for that purpose we are carry more cutting fluid, cutting tool & actual machining parameter. The present work shows the concentration of multi-walled carbon nanotube (MWCNT) is in used. The Nano fluid is prepared by using various ratios of nano-particles (MWCNT), blended oil as a base fluid. The statistical planning of the experiment is done by using Taguchi method. The process parameters considered in the study are cutting speed, feed rate, depth of cut and surface roughness is considered as a response parameter.

I. INTRODUCTION

Machining is a process in which cutting tool is used to remove small chips of material from workplace. It is required for desired shape & size of the product. The main forces on machining as per customer requirements the product should be at low cost & good quality. Almost all industries output products are depending on surface quality, cutting force, tool wear, power consumption, etc. While machining, a large amount of heat generated at the tip of tool in such condition cutting fluid playing very important role as a coolant to reduced that kind of problems during machining. Steel and its alloy have the prime choice for many fields of applications. This grade possesses high strength to weight ratio, ductility, Corrosion resistance. we take this material as a challenging because it is hard to machine. so, to achieve the success on EN19 we need to take proper selection of method, machining parameter, cutting tool & most important cutting fluid. In the work dry machining, Conventional machining, pure MQL and nano fluid are cared out by using cutting fluid on (alloy steel EN19). We compare that on which Parameter the good surface finish obtained. While dry machining it is observed that the high temperature occurs I this process required cutting tool to withstand elevated temperature. In conventional cooling method Causing problem for the manufactures, as a substance present in them caused serious health effects on the worker and secondary environment, for the environment, for the environmental safety pure MQL is prepared as a cutting fluid on turning operation. Then finally it comes to used nano-fluid (MWCNT) with Tic-coated carbide insert or a good cutting fluid, high thermal conductivity and lower contact angle or higher weldability. These properties help in reducing the operating temperature, cutting forces, improvement in the life of tool and surface finish. Preparation shown that dispersion at nano particles in base fluid after the thermo-physical behaviors of their fluids. As per study MWCNT was selected for preparing nano fluid as it has high thermal Conductivity than any other nano-particles. It has been found that Mustard oil and coconut oil as a base fluid comes into picture.

II. LITERATURE REVIEW

Laval, S.A. Choudhury (2012) Higher material removal rate can be achieved with vegetable oil-based fluids. Vegetable oil-based fluids are environmentally friendly. Vegetable oil-based fluids performed satisfactorily during machining process.

Kuram, E, Ozcelik, B., Huseyin Cetin, M., Demirbas, E., & Askin, S. (2012) In this work, the machinability of AI 7075-T6 was tested using four different types of vegetable-based cutting fluids (VBCFs) in comparison to a commercial mineral cutting fluid. The addition of severe pressure improves the lubrication characteristics of VBCFs. For performance studies of cutting fluids during force and tool wear data were collected. Compared to commercial mineral cutting fluid, VBCFs showed gains in cutting, feed and radial forces ranging from 1.70 to 38.25%. With blended cutting fluid containing 12% of extreme pressure, the lowest average flank and nasal wear values for the commercial mineral cutting fluid were 0.18 and 0.15 mm. The results of the scanning electron microscope revealed that the rake had workpiece material attached to it.

D. Madhesh "In this work the prepared the multi walled carbon nanotube for 0.1 to 1.0% volume concentration were dispersed in the base fluid. The TEM results conformed the morphology of MWCNTs.

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The increase in nanotubes concentration in base fluid and increase in temperature of nanofluid increases the thermal conductivity was shown in the result. The increase in thermal conductivity enhancement shows 23.5% for the volume concentration of 1.0%. The surface area of the MWCNTs found to increase the thermal conductivity of nanofluids. The aggregation as well as the phonon heat interaction of the nanotubes at higher concentration in base fluid were ascertained for the enhancement of the thermal conductivity of the MWCNT nanofluids. "

V. Kumaresan The density of the nanofluid increases with the MWCNT concentration. The measured data show an observable deviation from the predicted values of the Pak and Cho correlation, and the deviation increases with an increase in the MWCNT concentration. This is due to the spontaneous filling of nanotubes with water in a confined way, which in turn, increases the mass of the nanofluid for a given volume.

III. PREPARATION OF NANO-FLUID

A. Minimum Quality Lubrication (MQL)

MQL is fundamentally different from flood coolant, which can be a major stumbling block for machinists who are new to MQL. The application of flood coolant is extremely simple. The heat generated by machining operations is kept at bay as long as relatively clean coolant 'floods' the interface of the cutting tool and workpiece. This method works, but it has some serious consequences. One of the main disadvantages of using coolant is that it requires additional equipment. To keep coolant viable, it must be recirculated, filtered, tested, and treated. Bacterial contamination, tramp oil, and swarf are major concerns when disposing of spent coolant. Spent coolant is typically classified as toxic waste, and its coolant is that it's a sloppy mess. Regardless of containment methods, coolant invariably covers more than just the cutting tool and work. Machines, floors, and finished parts are frequently left wet from coolant, posing potential slip hazards and necessitating part cleaning prior to secondary operation. Repeated exposure to a variety of coolants can have serious consequences for the humans involved. With long-term exposure to coolant vapor, some coolants have been shown to cause dermatitis and to be carcinogenic. According to studies, the total cost of coolants can account for up to 15% of the total cost of producing a part.

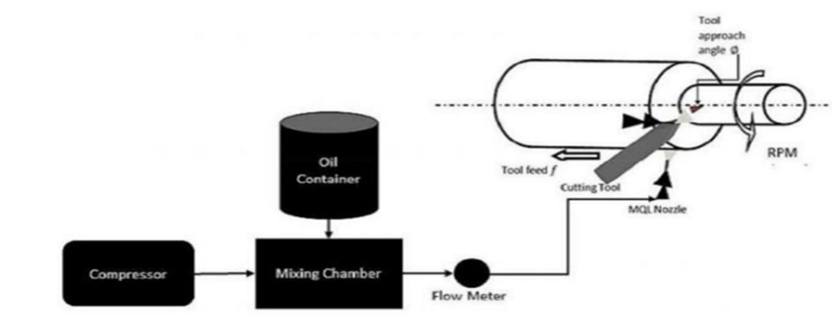

Fig. 1. MQL System

The cost and negative effects of flood coolant beautifully set the stage for MQL. You'd think that when presented with an alternative that saves money, eliminates the mess, disposal, and negative aspects of coolant, machinists all over the world would be scrambling to implement this new technology, wouldn't you? In fact, due to stricter environmental regulations, MQL technology has gained much wider acceptance in European machining. In the United States, MQL is still fighting for the machinists' 'hearts and minds.' This website aims to increase MQL knowledge and awareness in the industry and, hopefully, to serve as a forum for discussion of this emerging technology.

B. Nano Particle Used

1) *Multi-Walled Carbon Nanotube (MWCNT):* MWCNTs are made up of multiple carbon nanotubes that are nested within one another. The number of nanotubes contained within a MWCNT can range from three to more than twenty. At the same time, the diameters of the internal and external nanotubes can range from 2mm for the innermost tube to more than 50mm for the outer wall. They have exceptional electrical, thermal, and mechanical properties, just like single-walled nanotubes. However, because of the increased number of walls, there is a greater likelihood of defects being present when compared to single walled nanotubes, resulting in lower performance. To add functionality, the outer walls of MWCNT can be modified with functional groups such as hydroxides, carboxylic acids, or amides.

C. Base Fluid Used

1) *Coconut Oil:* Because of its higher thermal conductivity and oxidative stability, coconut oil is being used as one of the cutting fluids in this work. Coconut oil has been found to improve tool life and surface finish when machining at low and medium cutting speeds.
2) *Blended Oil:* Blending of oil combines the potency of two edible oils and offers a balance of fatty acids. In this work we use 50% of coconut and 50% of Mustard oil as a Blended oil.

D. Cutting Fluid Used

1) According to research, we have adopted to take coconut oil and blended oil (50% of coconut oil + 50% of Mustard oil) as a base fluid.
2) Then we added MWCNT (1%, 1.5%, 2%) with base fluid to form a nanofluid.

IV. METHODOLOGY

A. Workpiece Material

EN19 is a high-quality alloy steel with tensile strength. With a combination of good ductility and shock resistance, EN19 is suitable for applications with very high loading such as engine gear boxes. EN19 steel is a high-quality engineering alloy steel containing chromium and molybdenum. It falls in a class of low alloy steel. It has high fatigue strength, abrasion and impact resistance, toughness, and torsional strength. It can be heat treated in a number of ways to give it a combination of properties.

B. Machining Parameter

1) *Cutting Speed:* Cutting speed, regardless of the machining operation used, can be defined as the rate at the workpiece surface. Each material and set of machining conditions will have an optimum cutting speed, and the spindle speed (RPM) can be calculated from the speed.
2) *Feed Rate:* The feed rate is the speed at which the cutter is fed, or advanced against the workpiece. For turning and boring, it is expressed in distance per revolution.
3) *Depth of Cut:* Depth of cut (t) The tertiary cutting motion that provides the required depth of material to be removed by machining. It is measured in mm. It is typically expressed in the third perpendicular direction.

C. Response Parameter

1) *Surface Roughness:* The shorter frequency of real surfaces relative to troughs is defined as surface roughness. When you look at the machined parts, you will notice that their surface has a complex shape that is made up of a series of peaks and troughs with varying heights, depths, and spacing. Surface roughness is a measure of a surface's texture. The vertical deviations of a real surface from its ideal form are used to quantify it. The surface is rough if these deviations are large; smooth if they are small.

D. Taguchi Design of Experiment

To obtain a favourable value for the machining parameters, we can use various methods such as trial and error, design of approach, and so on. However, the outcome will be inaccurate. We can also use the full factorial method for three parameters, as in our case, in which case the number of sets of experiments required is 3 3, i.e., 27. This is a large number of sets for such an expensive material as alloy steel EN19, making the method less cost effective. As a result, we can use the Taguchi orthogonal array method, where we can select the area of our requirement from the method set available, which includes L4, L8, L9, L16, and L27. L9 and L27 are arrays that can be used for three levels of design, as in our case. As a result, we chose orthogonal array L9 for 9 sets of experiments, which will be both cost effective and time efficient.

L9 ORTHOGONAL ARRAY

Experiment No.	Control Factors		
	Cutting speed	Feed rate	Depth of cut
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2

5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

V. CONCLUSION

1) When compared to conventional cooling, nanofluid MQL significantly reduces cutting force and tool-tip temperature. Dry machining and pure MQL. This is due to MWCNT's excellent thermal conductivity, which allows for effective heat dissipation from the cutting zone, resulting in a better cooling effect and surface finish.
2) The Taguchi method determined the best parameters to be speed, depth of cut, and feed rate. This combination produces the best surface roughness, whereas increasing SPEED and DOC while turning on the lather machine produces poor surface roughness.
3) Tool wear increases with increasing cutting speed and feed rate, whereas surface roughness decreases with increasing cutting speed and increases with increasing feed rate. Feed rate was discovered to be the most significant parameter influencing surface roughness, whereas cutting speed was discovered to be the most significant parameter influencing tool wear.
4) Good surface Roughness, Low temperature at the cutting area, reduced cutting forces are observed when replacing the coolant with the nano cooling.

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