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EXPERIMENTAL ANALYSIS OF SURFACE ROUGHNESS IN TURNING OPERATION WITH MQL USING NANOCOOLANT

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ABSTRACT

Now a days industries using ordinary coolant for turning operation, by using ordinary coolant the surface finish value is high(surface finish is poor). To avoid that we prepare Nano coolant for turning operation with MQL setup. Nano cutting fluids are the mixtures of conventional cutting fluid and nanoparticles. Addition of the nanoparticles can alter lubricating properties, and cooling properties of Nano cutting fluids. In the present work, Nanocutting fluid is made by adding Nanoparticles (MWCNT) to conventional cutting fluid (GLYCOL).By Comparing the work piece surface roughness among dry machining, machining with conventional cutting fluid, machining with ordinary fluid with MQL as well as Nano-cutting fluid in MQL has been undertaken .This study clearly explains that the workpiece surface roughness of the job increased by using Nano-cutting fluid in MQL compare to dry machining, machining with ordinary fluid in MQL and machining with conventional cutting fluid.

1. INTRODUCTION

Turning operation is method performed to reduce the diameter of a work piece using a lathe machine. Since, the operation is done by contact between two objects, the work piece and the tool, there is a lot of frictional forces present between the two surfaces. Although it is the frictional force that causes the reduction of diameter, sometimes too much or unnecessary friction may cause higher wear than required. Due to this the work piece may have uneven and rougher surfaces. To overcome this problem lubricants have been used since many years, which reduces the friction between the two surfaces, thus reducing unnecessary wear. Although using lubricants gives better outputs, there are some circumstances under which varying quantities of lubricant need to be used under varying intervals. So, a Minimum Quantity Lubrication (MQL) system is used to apply the lubricant at required quantities and timings. The only difference between conventional methods of lubrication and MQL is that the former is used to control the quantity of lubricant and thus improving performance, the nature of the lubricant remains similar. In a way to improve the outputs better, Nano-fluid is used in place of lubricants, which is a mixture of Nanoparticles and lubricant. Using of Nano-fluid is believed to improve the surface finish. Nano-fluids can be used in lesser quantities via a Minimum Quantity Lubrication (MQL) system than conventional lubricants, thus reducing cost, time and also improving surface finish of the work piece. Further optimization is done for turning operation with MQL system using Nano-fluid as lubricant, the optimization is done by comparing the efficiency and output by varying the factors of operation like speed, feed rate, depth of cut, etc.

2. NANOCOOLANT (MWCNT+GLYCOL)

Multiwall carbon nanotubes is a little bit more complex, since it involves the various ways graphene's can be displayed and mutually arranged within filamentary morphology. A similar versatility can be expected to the usual textural versatility of polyromantic solids. Likewise, their diffraction patterns are difficult to differentiate from those of anisotropic polyromantic solids. The easiest MWNT to imagine is the concentric type (c-(MWNT), in which SWNTs with regularly increasing diameters are coaxially arranged (according to a Russian-doll model)into a multiwall nanotube. Such nanotubes are generally formed either by the electric arc technique (without the need or a catalyst), by catalyst-enhanced thermal cracking of gaseous hydrocarbons, or by CO disproportionation There can be any number of walls (or coaxial tubes), from two upwards. The interlude distance is approximately the same as the inter graphene distance in turbo static, polyromantic solids, 0.34 nm (as opposed to 0.335 nm in genuine graphite), since the increasing radius of curvature imposed on the concentric graphene's prevents the carbon atoms from being arranged as in graphite, with each of the carbon atoms from a graphene facing either a ring center or a carbon atom from the neigh boring graphene. However, two cases allow a nanotube to reach – totally or partially –the 3-D crystal periodicity of graphite. One is to consider a high number of concentric graphene's: concentric graphene's with along radius of curvature. In this case, the shift in the relative positions of carbon atoms from superimposed graphene's is so small with respect to that in graphite that some commensurability is possible. Lost, meaning that the latter are more accurately called nanofibers rather than nanotubes. h-MWNTs are exclusively obtained by processes involving catalysts, generally catalystenhanced thermal cracking of hydrocarbons or CO disproportionation. One long-time debated question was whether the herringbone texture, which actually describes the texture projection rather than the overall three-dimensional texture, originates from the scroll like spiral arrangement of a single graphene ribbon or from the stacking of independent truncated cone like graphene's in what is also called a *cup-stack* texture. It is now demonstrated that both exist. Another common feature is the occurrence, to some degree, of a limited amount of graphene's oriented perpendicular to the nanotube axis, thus forming a *bamboo* texture. This is not a texture that can exist on its own; it affect either the c-MWNT question is whether such filaments, although hollow, should still be called nanotubes, since the inner cavity is no longer open all the way along the filament as it is for a genuine tube. These are therefore sometimes referred as *nanofibers* in the literature too. One Nano filament that definitely cannot be called nanotubes built from graphene's oriented perpendicular to the filament axis and stacked as piled-up plates. Although these Nano filaments actually correspond to h-MWNTs with a graphene/MWNT axis angle of 90◦, an inner cavity is no longer possible, and such filaments are therefore often referred to as *platelet nanofibers* in the literature.

The major use of ethylene glycol is as a medium for convective heat transfer in, for example, automobiles and liquid-cooled computers. Ethylene glycol is also commonly used in chilled-water airconditioning systems that place either the chiller or air handlers outside, or systems that must cool below the freezing temperature of water. In geothermal heating/cooling systems, ethylene glycol is the fluid that transports heat through the use of a geothermal heat pump. The ethylene glycol either gains energy from the source (lake, ocean, water well) or dissipates heat to the sink, depending on whether the system is being used for heating or cooling. Pure ethylene glycol has a specific heat capacity about one half that of water. So, while providing freeze protection and an increased boiling point, ethylene glycol lowers the specific heat capacity of water mixtures relative to pure water. A 1:1 mix by mass has a specific heat capacity of about 3140 J/(kg·°C) (0.75 BTU/(lb·°F)), three quarters that of pure water, thus requiring increased flow rates in same system comparisons with water. The formation of large bubbles in cooling passages of internal combustion engines will seriously inhibit heat flow (flux) from that area, thus allowing nucleation (tiny bubbles) heat transfer to occur is not advisable. Large bubbles in cooling passages will be self-sustaining or grow larger, with virtually the complete loss of cooling in that spot. With pure MEG that hot spot has to get to 200 °C (392 °F). Cooling due to other effects such as air draft from fan etc. (not considered in pure nucleation analysis) will assist in preventing large-bubble formation.

3.MINIMUM QUANTITY LUBRICATION

Minimum quantity lubrication (MQL) is a technique that uses a spray of small oil droplets in a compressed air jet. The lubricant is sprayed directly into the cutting zone, avoiding the huge flows of conventional flood coolant methods. The air jet carries the oil droplets directly in the cutting area, it provides efficient lubrication. One of the advantages of MQL is the fact that after grinding runs, chips, workpieces and tools have less impregnated fluid, making cleaning easier and cheaper. Furthermore, during grinding runs, since the workpiece is not fully covered with fluid, visual monitoring is possible. The general guide for conventional fluid usage is 1 l/min of fluid per 1 mm of wheel width. In contrast, MQL fluid consumption is typically 200–500 ml/h Minimum quantity lubrication (MQL) refers to the delivery of small volumes of fluid via an aerosol to the cutting region. The air and oil mixture can be produced either in a reservoir or at the nozzle tip. Minimum quantity lubrication (MQL) is a technique that uses a spray of small oil droplets in a compressed air jet. The lubricant is sprayed directly into the cutting zone, avoiding the huge flows of conventional flood coolant methods. The air jet carries the oil droplets directly in the cutting area, it provides efficient lubrication. When conventional flood coolant is used, specific procedures have to be taken in order to allow the fluid to penetrate the cutting zone efficiently. One of the advantages of MQL is the fact that after grinding runs, chips, workpieces and tools have less impregnated fluid, making cleaning easier and cheaper. Furthermore, during grinding runs, since the workpiece is not fully covered with fluid, visual monitoring is possible.

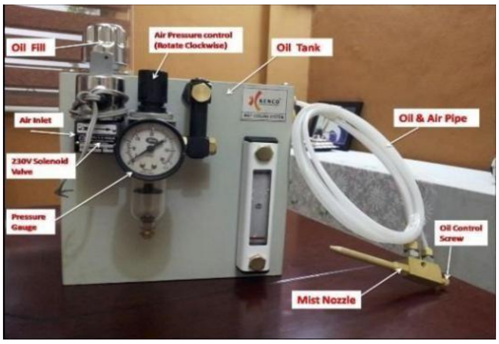


FIG 1.MQL SETUP

4. PREPERATION (ULTRASONICATOR)

Multi walled CNT's were synthesized using an arc discharged method with a DC power supply. A rotating graphite disc at very low speed (10rpm) was used as cathode and graphite rods of diameter 11mm (99.7% purity) were used as anode. The power supply used was an AC/DC inverter TIG power source which supplied a current density of 150 A/cm^2 at 36 V. The arcing was carried out manually in an open air atmosphere .The soot deposited on the cathode was collected and crushed using a mortar and pestle to get a fine powder of CNT. CNT powder was washed with distilled water and then soaked in toluene for 5 hrs. It was washed again with distilled water and dried in an electric oven. Finally, the CNT powder was oxidized at 550°c in a closed furnace for 2hrs to remove any amorphous graphite present. To disperse the CNT's successfully in soluble oil, the CNT powder was initially mixed with few drops of Triton X100, a surfactant. To prepare the CNT Nano fluid, the required quantity of CNT's (0.5wt% of CNT with 500ml of soluble oil) was taken and mixed with a few drop of surfactant which is just enough to wet the entire CNT's. Then the mixture is directly added with 500 ml of soluble oil and sonicated in a probe type sonicator for 30mins at 20 kHz and 1000 watts power.

FIG 2.ULTRA SONICATOR

5. EXPERIMENTAL CONDITION

Experiments were conducted on DX 300 CNC with TNMG 160408MS carbide insert by turning EN 24 alloy steel of diameter 80 mm. Optimized speed fed combination and depth of cut has been selected to study the effect of MQL in temperature developed in the cutting zone. The turning parameters, specimen details, machine tool and cutting tool details and the cutting environment used during experiment are summarized.

Machine tool	DX 300 CNC Lathe
Work material	EN 24 Alloy steel
Size	Ø80*30
Cutting insert	TNMG160408MS carbide
Spindle speed	500 rpm
Feed rate	0.07 mm/rev
Depth of cut	0.75mm
Lubricant	GLYCOL+MWCNT
Air pressure	5bar
Flow Rate	150 ml/hr
Tool Holder	BTJNL 2525 M16

6. WORKPIECE AND INSERT

Steels are mainly composed of iron and carbon and special properties are reached by introducing additional alloying elements. Steel is often classified by its carbon content: a high carbon steel is serviceable for dies and cutting tools because of its great hardness and brittleness; low- or mediumcarbon steel is used for sheeting and structural forms because of its amenability to welding and tooling. Alloy steels, now most widely used, contain one or more other elements to give them specific qualities. Chromium steel finds wide use in automobile and airplane parts on account of its hardness, strength, and elasticity, as does the molybdenum. It has high toughness and strength in the heat treated condition. EN24 in the hardened and tempered as supplied condition is still regarded as being readily Machin able and operations such as sawing, turning, drilling, etc. can be carried out satisfactorily using machine manufacturer's recommendations for suitable tool type - feeds and speeds. This kind 18 of alloy steel is most suitable for the manufacture of parts such as heavy-duty axles and shafts, gears, bolts and studs. This work is focused on machining (turning) of EN 24 alloy steel under different lubricating conditions including dry, wet and MQL. Chromium-vanadium variety. Nickel steel is the most widely used of the alloys; it is nonmagnetic and has the tensile properties of high-carbon steel without the brittleness.

FIG 3.WORK PIECE

Tungsten carbide is one of a group of compounds including the carbides, nitrides, borides and silicide of transition elements of Groups IV, V and VI of the Periodic Table. Of these, the carbides are important as tool materials, and the dominant role has been played by the mono-carbide of tungsten, WC.

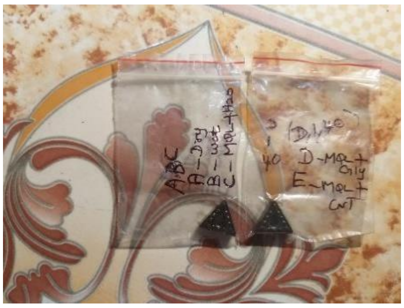


FIG 4.INSERT

7. SURFACE ROUGHNESS

Roughness is an important parameter when trying to find out whether a surface is suitable for a certain purpose. Rough surfaces often wear out more quickly than smoother surfaces. Rougher surfaces are normally more vulnerable to corrosion and cracks, but they can also aid in adhesion. A roughness tester is used to quickly and accurately determine the surface texture or surface roughness of a material. A roughness tester shows the measured roughness depth (Rz) as well as the mean roughness value (Ra) in micrometers or microns (µm). Measuring the roughness of a surface involves applying a roughness filter. Different international standards and surface texture or surface finish specifications recommend the use of different roughness filters. For example, a Gaussian filter often is recommended in ISO standards.

FIG 5.ROUGHNESS TESTER

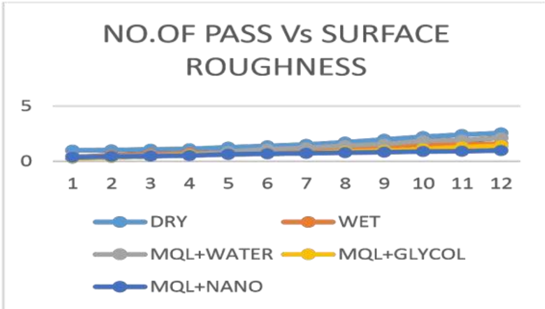
Range	Up to 400m
Resolution	0.01m
Accuracy	1% of reading
Display	Digital
Model	Surtronic S-100

8. RESULTS AND DISCUSSION

In CNC, we performed turning operation by using following conditions like dry, wet, etc. Comparing its surface parameters.

SURFACE ROUGHNESS

PASS	DRY	WET	MQL + WATER	MQL+ GLYCOL	MQL+ NANO COOLANT
1	1.00	0.40	0.40	0.28	0.36
2	1.02	0.55	0.41	0.35	0.43
3	1.07	0.67	0.49	0.46	0.49
4	1.11	0.75	0.56	0.58	0.52
5	1.27	0.82	0.69	0.62	0.63
6	1.39	0.86	0.73	0.69	0.69
7	1.52	0.92	0.99	0.73	0.72
8	1.73	1.13	1.35	0.89	0.79
9	1.98	1.38	1.62	0.98	0.83
10	2.23	1.54	1.85	1.11	0.89
11	2.42	1.56	1.93	1.28	0.92
12	2.56	1.58	2.12	1.41	0.98



This graph clearly shows the surface roughness of various condition. The surface roughness is high for MQL+Water and very low for dry condition. The result clearly shows that the Surface roughness is high when we use MQL setup.

9. CONCLUSION

- In CNC, we performed turning operation by using following conditions dry, wet, MQL+water, MQL+glycol, MQL+ Nanocoolant and comparing its surface finish.
- The best surface finish obtained are as follows:
  1) MQL+NANOCOOLANT(Ra)-0.56 µm.
  2) MQL+GLYCOL (Ra)-1.11 µm.
- CNT has more thermal conductivity compared to other methods of heat transfer so it will increase the tool life. Therefore, the surface finish is good compared to other methods.

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