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PREDICTION OF MACHINING PARAMETERS INCASE OF NANO FLUID BASED MQL SYSTEM

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ABSTRACT

Now days, Mechanical machining processes are involving with the usage of cutting fluids. Because, Cutting fluids help to improve machining performance as well as prolong tool life by reducing temperature and friction during machining. In general, there is a conventional system of applying the coolant is “Flood Flow System”, in which a large quantity of cutting fluid/coolant is continuously applied to the cutting zone. This system is very inefficient. First of all, a large quantity of the cutting fluid is required. Second, the cutting fluid is not able to reach the cutting zone due to obstruction from chips. However, there is a chance of burden in the cost and to the environment due to uncontrolled use of cutting fluids. For this reason, a most feasible bridging technology was developed, which is known as “Minimum Quantity Lubrication”. In this technology, a very small flow rate of cutting fluid / lubricant / coolant is delivered to the cutting zone. In this, fluid strikes the cutting zone with high pressure with the use of mixing of compressed air. This type of applying cutting fluid/coolant is known as “Mist Flow System”. This technology primarily requires a pneumatic spray nozzle, which has capability to atomize the fluid/liquid with compressed air as per the required ratio, and also to deliver a controlled (or regulated) spray.

Keywords: Minimum quantity lubrication, cutting fluids, nano particles, tool wear, Ti6al4v, Surface roughness

1. INTRODUCTION

The now a days most of the manufacturing industries are trying to decrease the cutting cost, in crease the quality of machined parts and machine more difficult materials. The MQL machining efficiency is improved by reducing the machininng time with high speed machining. When cutting ferrous and hard Materials such as steels, cast iron and super alloys, softening temperature.The main aim of minimum quantity lubrication (MQL) is to reduce the lubrication and cutting fluid hazards, they analysis the the behaviour of recenty proposed optimisation method which consists of adding of water to MQL, by using these MQL th surface roughness is better when compared to traditionl method and these results are very closer to flood coolant. [1]. by reducing the volume of cutting fluid used in machining process the objective of this is that state of the art of literature in machining using MQL, more benfits. The mist collection/filtering equipments are generally required tto manage this fine mist particularly in ferrous machining, I these vegetable oil and synthetic oil is to be used instead of mineral oil.[2]. Investigation of cutting force and temperature of end – milling Ti-6Al-4V Different minimum quantity lubrication (MQL) Parameters : they are investigates experimentally the effects of different MQL parameters such as air pressure , quantity of consumed and position of the nozzle in end milling titanium alloy ,the results shows the penetrating ability of MQL oil mist has significant on the milling force and milling temperature .The spraying angle of t5he nozzle position has an impact on the penetration ability .Due to the high viscosity the MQLoil being delivered in an appropriate quantity ,it is observed inthis research of the spraying angle of the nozzle position has a minimum impact on the penetration ability.[3]. Effects on MQL on the tool life of small twist drills in deep – hole drilling. they analyzed the investigates in how far the manner of supplying and the type of minimum quantity lubrication have an effect on the tool life of coated and uncoated high –speed steel twist drills of 1.5 mm diameter .This shows that compared to a continuous supply of the MQL , a discontinuous supply brings about a significant reduction in tool life especially in the case of heat – sensitive drills, it also shows that the dry drilling is associated with strongly accelerated tool wear for most of the twist drills tested in resulting in reduction in tool life.[4]. Studied tool wear mechanisms in machining of titanium alloys. They concluded as the coating of the tool may or may not help in improving tool performance. And the effect of coating can varies from work material to work material. [5]. Developed a surface roughness model with the use of hardened steel using response surface methodology. They experienced as the poly crystalline cubic boron nitride (PCBN) cutting tool possess excellent mechanical property. And the feed rate is the most influencing factor on surface roughness for all tools. [6].

2. EQUIPMENT AND EXPERIMENTAL SETUP

This chapter includes the specified information related to Equipments used for this project and the arrangement of equipments for experiment. Some of the major equipments can be followed as,

- MQL Setup,
- Cutting tool and Work material,
- CNC Lathe, etc.

Minimum Quantity Lubrication (MQL) is just what the name implies that it uses a very less amount of a fluid to reduce the friction at the cutting tool and the work piece interface. It provides better machining output results than in flood or dry condition. It has the following advantages,

- ✓ Greater reduction of lubricant / coolant usage,
- ✓ Increase in tool life,
- ✓ Reduces time required for machining,
- ✓ Extends service life of machinery,

2.1 MQL Setup:

Brand : Techno drop Engineers

Oil Tank Capacity : 3 litres

Minimum Delivery : 15 ml/hour

Maximum pressure : 4 to 7 bar (For both the inlet and delivery)

Nozzle Type : Solid stream type (1No.s)

Pressure gauge type : Bourdon tube expanding type

Fig 1. MQL Setup

2.2 Work Material:

Titanium grade 2 alloy is also known as "Commercially Pure Unalloyed Titanium". A 30mm diameter and 200mm length of this alloy is used as work material. As it is one of the hardest materials, it can full fill the requirement for the project. A set of turning experiments were done on this work material with a predefined set of cutting speeds, feed rates, depth of cut and cooling conditions.

Fig 2. Titanium Grade 2 Alloy

2.3 Cutting Tool

A cutting tool or cutter is any tool that is used to remove material from the work piece by means of shear deformation. Cutting may be accomplished by single-point or multipoint tools. Single-point tools are used in turning, shaping, planning and similar operations, and remove material by means of one cutting edge. Milling and drilling tools are often multipoint tools.Commercially available inserts are uncoated and coated tools. Generally, coating of tools is done as per special requirements.

2.4 CNMG A B C Specification:

C - Rhombic (Shape of the insert) with Nose Angle 80°

N - 0° (Clearance/Relief Angle)

M - (Tolerance on size)

Corner point : 0.05 - 0.13 mm

Thickness : 0.13 mm

Inscribed circle : 0.05 - 0.15 mm

G - (Type of insert)

Hole shape : Cylindrical

Chip breaker type : Double sided

A - Cutting edge length, in mm

B - Thickness, in mm

C - Nose radius, in mm

2.6 CNMG 12 04 08:

Fig 3; uncoated carbide Tool insert (CNMG 120404)

Fig 4. Uncoated Carbide Tool Insert (CNMG 120408)

2.7 Specifications:

Model number	:	CNMG 12 04 08
Usage	:	External turning tool
Corner Radius	:	0.8 mm
Cutting edge length	:	12.70 mm
Thickness	:	4.76 mm
Hole	:	5.16 mm
Color	:	Brown
Material	:	Tungsten carbide
Coated/ Uncoated	:	Uncoated
Hardness	:	92.8 HRC

2.8 Cutting fluids:

Cutting fluids are applied to the machining zone for absorbing the temperature, for reducing the friction between the tool and the chip and to provide better lubrication to the parts. Cutting fluids are many types. They are,

- Petroleum based fluids,
- Minerals based fluids,
- Vegetable oil based fluids, etc.

Based on the consideration of the biodegradability, Vegetable oil based cutting fluids are the best fluids. And these are cheaper in cost also.

2.9Nano Particles:

Nano particles used for improving machining output. Initially, these particles are dissolved into the cutting fluid in a particular proportion with the fluid. This process is done with the help of an Ultra sonicator stirring system.

Machining Setup with Titanium Grade 2 Material:

Initially, all the necessary equipments and instruments are placed together. Before the starting of experiment, all the instruments are calibrated for checking errors. A Data recording device (Laptop) is used to note down the data related to the output parameters and their values.

Fig 5. Work Holding Setup with Machining Zone & Universal Chuck

3. RESULTS AND DISCUSSION

MQL machining stands for the minimum quantity lubrication is nothing but the process of applying the minute amounts of high quality lubricant directly to the cutting tool are work piece interface instead of using traditional flood cooling. Mql machining also called as the near dry machining.

3.1 Concept of MQL Machining:

A machining method called as mql (minimum quantity lubrication) machining or semi dry machining can be put to practical uses to improve environmental conditions and reduce manufacturing costs. By supplying the minimum required quantity of coolant to the cutting edge in the form of a mist, tool life can be increased when machining materials. MQL only offers lubrication and it has little or no effect in terms of cooling the cutting edge. Additionally the mql method has the same disposal properties as air blow.

3.2 Nano fluids application with MQL in machining:

Friction and wear result in the increase of energy consumption and the reduction in the life of mechanical parts. Application of nano fluids as coolant and lubricant results in lower tool temperature, lower tool wear, better surface quality and minimized environmental dangers than the most other oils and conventional coolants. Nano fluids are known to enhance the tribological properties of base fluids.

The tribological properties of graphite nano particles as a vegetable-based oil additive with a pin on disk friction and wear tester was investigated. They reported that friction reducing and anti-wear properties of the pure oil were significantly improved by the graphite nano particle addition. Further

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improvement of the MQL technique was achieved. Introduction of nano lubrication into metal cutting process, which confers rolling action of billions of nano particles at the tool chip interface thereby reducing friction and thermal deformation of work piece in addition to less consumptions of lubricating oil as well as reduced pollution activities. Some of nano particles used for nano fluid application in metal cutting process includes but not limited to the followings: efoliated nano-graphene (X GnP), hexagonal boron nitrate(HBN), copper oxide (CuO), aluminium oxide (Al_2O_3), molybdenum disulphide (MoS_2), carbon nano tubes(CNT), iron oxide(Fe_2O_3), nano graphite, multi wall carbon nano tubes (MWCNTS), nano boric acid, silicon oxide (Sio_2), titanium oxide (TiO_2),silicon carbide(Sic) nano diamond, etc.

Table 1: Chemical composition:

Chemical composition										
O	N	C	H	Fe	Al	V	Ti	Mo	Others/ea	Others/total
0.20	0.05	0.10	0.0125	0.30	5.5-6.75	3.50-4.50	BAL	-	0.10	0.4

Table; Chemical Composition of Ti - 6Al - 4V

Physical properties:

1. Melting range: 2,800-3,000°F (1,538 - 1,649°C)
2. Density: 0.160 lbs/cu. in.(4.47 gm/cc)
3. Beta Transus Temperature: 1830°F (± 25); 999°C (± 14)

Table 2:Mechanical properties:

Typical mechanical properties annealed condition (min)		
	Mpa	Ksi
Yield Strength (0.2%)	828	120
Tensile Strength	895	130
Elongation (%)	10	
Reduction in Area (%)	25	
Rockwell Hardness	Rc 30-34	

Table; Mechanical properties of Ti - 6Al - 4V

Note; variations in mechanical properties are dependent on size/condition/heat treatment

Factors limits

Factor	Name	Unit	Type	Minimum	Maximum	Coded Low	Coded High	Mean	Std. Dev
A	Speed	m/min	Numeric	100.00	200.00	-1 to 100	+1 to 200.00	150.00	32.73
B	Feed	mm/rev	Numeric	0.1000	0.2000	-1 to 0.10	+1 to 0.20	0.1500	0.327
C	Depth of condition	mm	Numeric	0.2000	0.4000	-1 to 1.20	+1 to 0.40	0.3000	0.0655
D	Cooling condition		Numeric	1.0000	3.00	-1 to 1.00	+1 to 3.00	2.00	0.6545

Response limit

Response	Name	Units	Observations	Analysis	Minimum	maximum	Mean	Std. Dev	Ratio	Transform	Model
R1	Ra	µm	29	polynomial	0.404	1.984	1.33	0.3970	4.91	None	quadratic
R2	Cf	N	29	polynomial	76	179	124.83	28.41	2.00	None	Linear
R3	Tem	°c	29	polynomial	31.9	72.3	45.80	10.78	2.42	None	quadratic
R4	Flank wear	mm	29	polynomial	0.205	0.49	0.3780	0.07	2.43	None	Linear
R5	Crater wear	mm	29	polynomial	0.15	0.48	0.3410	0.08	3.14	None	Linear

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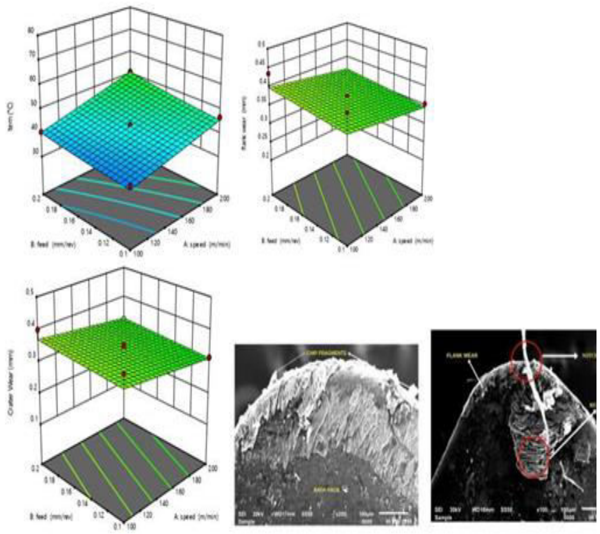

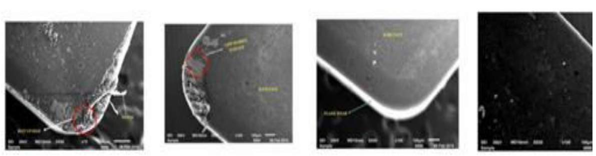

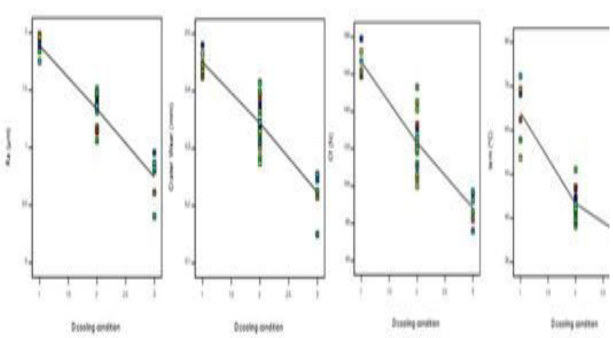

4. **CONCLUSION**

By this experiment and analysis for optimization, it has been proved that the machining input parameters greatly influences the various responses'

- ✓ At the cutting speed of 194.191m/mm at a feed rate of 0.18513 mm/rev with a depth of cut 0.27122mm. Optimum responses such as surface roughness, temperature, tool wear and cutting force can be achieved.
- ✓ As the feed rate increases, roughness can also increases. At minimum cutting speed, the surface roughness value is high at high speed, the roughness gets decreased.
- ✓ Depth of cut plays a key role while the change in cutting force. As the depth of cut increases, cutting force also increases.
- ✓ From the above graphs it can be conclude that, by using grapheme nano fluid based minimum quantity lubrication technique with vegetable oil based cutting fluid for turning of titanium grade 2 with un coated carbide inserts, better output results are achieved with reduced cost of machining when compared with conventional machining.
- ✓ Since this model is gives optimized machining results, it can be used for production areas for obtaining more profits with less production cost

REFERENCES

1. Rafael de Mello Belentain , Hamiltion Funes Junior , Ruben Chinali Canarim, Anselmo Eduardo Dinz , Amauri Hassui ,Paulo Robert Aguiar , Eduardo Carlos Bianchi : Utilization of Minimum Quantity Lubrication (MQL)with Water in CNB Grinding of Steel: Material Research .2014 :17(1):88-96: DOI NO :10.1590/S1516-14392013005000165.
2. Nourredine Boubekri, Vasim Shaikh: Minimum Quantity Lubrication (MQL) in Machining: Benefits and

Drawbacks: Journal of Industrial and Intelligent Information Vol. 3, No. 3, September 2015. DOI:10.12720/jiii.3.205-209

3. Z Q Liu , XJ Cai , M Chen .and Q L An : Investigation of cutting force and temperature of end – milling Ti-6Al-4V Different minimum quantity lubrication (MQL) Parameters DOI :10.1177/2041297510393793.
4. R. Heinemann, S. Hinduja, G. Barrow, G. Petuelli: Effects on MQL on the tool life of small twist drills in deep – hole drilling. DOI:10.1016/J.ijmachtools.2005.04.003.
5. Pravin pawar, Shashikant Joshi, Asim Tewari and Suhas Joshi. Tool wear mechanisms in machining of titanium alloys. 4th international and 25th AIMTDR Conference (2012).
6. Y. Sahin & A.R. Motorcu. Surface roughness model in machining hardened steel with cubic boron nitride cutting tool. International journal of Refractory Materials &Hard materials 26(2008) 84-90. DOI: 10.1016/j.ijrmhm.2007.02.005.