International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 10 | Oct -2016 www.irjet.net p-ISSN: 2395-0072

TEMPERATURE ANALYSIS WHEN USING METAL OXIDE-BASED ZnO AS A NEW COOLANT FOR TURNING PROCESS BASED ON MINIMUM QUANTITY LUBRICATION METHOD (MQL)

A.SYED HAMEED RAJA,

Department of mechanical Engineering Sri Ramakrishna engineering college, vattamalapalayam Coimbatore-22

N.SURENDAR,

Department of mechanical Engineering Sri Ramakrishna engineering college, vattamalapalayam Coimbatore-22

V.VIGNESH

Department of mechanical Engineering Sri Ramakrishna engineering college, vattamalapalayam Coimbatore-22

S.RAVI

Assistant Professor (Mechanical Engineering) Sri Ramakrishna engineering college vattamalapalayam Coimbatore-22 ravi.subramani@srec.ac.in.

C.NARENDHAR

Assistant Professor (Nano technology) Sri Ramakrishna engineering college vattamalapalayam Coimbatore-22 narendharc@gmail.com.

ABSTRACT This paper presents the effects of various turning conditions on the tool wear and work piece temperature when using metal oxide-based ZNO Nano fluid as the coolant for mild steel. A thermocouple was embedded into the work piece to record the work piece temperature during the turning process involved in different conditions. It can be clearly seen that the temperature keeps on changing using a zinc oxide as a Nano particle for cutting fluid. The experiment conducted using the metal oxide-based ZNO Nano fluid as the coolant exhibits reduce a work piece temperature compared to the experiment conducted using a normal commercial coolant. In conclusion, turning process achieved in mild steel using a metal oxide-based ZNO Nano fluid exhibits superior results with regard to reduce work piece temperature and tool wear. The temperature was reduced by 30 percent when using the Nano fluid.

Key words- zinc oxide, ball bearing effect, Nano-lubricant, ultra-sonification

INTRODUCTION:

A normal machining process produces a large amount of heat in the work piece. In order to reduce

The heat of the work piece lubrication oils is used. But it is used only for a certain period of time. If the same oil is used again it loses its lubrication properties. So it is better to use Nano based lubrication oils. Biodegradability is the most important factor consider in the industry with regard to the environment and human healthy. Cutting fluid plays an important role in the industry. Working labors uses cutting fluid is each and every day so Biodegradability is considered in the industry for the both benefit of workers and surrounding environment

Friction is the main cause of energy loss in many machining operations such as turning operations. It reduces the tools life and machinability. In order to reduce friction several lubricants have been found out for various operations. Researchers have developed various methods to improvise the properties of lubricant oils by adding various chemicals to enhance the physical, chemical and mechanical properties. Recent work on mixing Nanoparticles with oils proves to be a great method as it significantly reduces friction co efficient. Nano based lubricants have reduced friction more when compared to vegetable-based oils and normal oils. Recent research involves mixing of Nano particles such as ZnO have been used. These particles when mixed with lubricant oils enhance the lubrication property as well reduces the co-efficient of friction.

Friction and wear characteristics of the tool for turning process were examined in this process to test the friction

reduction and anti-wear. Scanning Electron microscope and Atomic microscope were used to study the dispersion of Nano particles in lubricants. In this experiment we use ZnO as Nano particle and SAE-30 as lubricant for turning operation of Mild Steel.

In recent years Nanotechnology has play important role for to improve the characteristic of material in many fields. Nano particle additives have been found an excellent heat transfer co-efficient rate compare to the normal lubricant oil. Nano particle also compensate for the loss of tool wear, flank wear, Nose radius, surface roughness by Nanoparticle as assisted abrasion

Then this present study examines the behavior of cutting fluid and work piece with and without Nanoparticle at various cutting speed and depth of cut. Atomic force microscope are used to analyze the surface feature of work piece

1.1MINIMUM QUANTITY LUBRICATION

In industry large amount of lubricant oil are used it accounts for 15 - 25% of the overall cost of manufacturing in the production industry. Among various techniques available in the industry for the application of the coolant, Minimum Quantity Lubrication (MQL) is a best effective method used in coolant agent it can used only a minimum quantity of cutting fluid as it minimizes the use of coolant by spraying the mixture of compressed air and cutting fluid in an proper manner instead of normal cooling so it used only minimum for cooling purpose. The MQL technique has provided to be suitable because it reduced the cost of the machining process and ECO- friendly for both environment and working labor

However a minimum quantity lubrication method it involves normal lubricating oil is mixed with Nano particle. Now a day several Nano lubricants have been identified by the advanced technology because it has high thermal co-efficient. Nano particle play important role in the cutting fluid. Nano particle main role is it reduce the friction between surface of work piece and cutting tool and to increases the lubricant property of the fluid.

EXPERIMENTAL PROCEDURE

2.1 DESIGN OF EXPERIMENT

In throughout the experiment work piece is mild steel blocks were used. Then Rockwell hardness of the block is around 70.where cutting tool as high speed steel tool are used. Then they properties of the work piece material are shown in Table 1.ALL GEAR lathe are used to throughout the experiment for monitoring the process involving a different set of RPM and depth of cut value. Thermocouples are used to measure the temperature of cutting fluid, work piece, cutting tool. In this experiment a constant feed rate are given as 0.4. A coolant are continuously circulated by using drop wise manner, coolant and water are mixed in the ratio20:1.In this first experiment a normal coolant oil are used to measure the temperature of cutting fluid, work piece, cutting tool. Then after a zinc oxide i.e. (Nano particle is prepared with the help of ball milling) is mixed with correct ratio of normal coolant oil to measure the temperature of cutting fluid, work piece, cutting tool. Then they properties of the zinc oxide are shown in Table 2.

Fig.1. Experimental set up

Table1. Physical properties of work piece material

TENSILE STRENGTH	ELONGATION AT BREAK	MELTING POINT	BOILING POINT	MODULUS OF ELASTICITY	SHEAR MODULUS
370Mpa	15%	1427 Celsius	1350 Celsius	204Gpa	80Gpa

Table2. Physical properties of zinc oxide

MOLAR MASS	DENSITY	MELTING POINT	BOILING POINT	BAND GAP	SHAPE
81.38g/ mole	5.606g /cm3	1975 Celsius	1975 Celsius	3.3ev	spherical

2.2 PREPARATION OF LUBRICANT USING BALL MILLING

In order to reduce the size of Nano particle ball milling are used. It is a best method to reduce the size of the Nano particle. This process was developed by Benjamin and his surrounding friend at the international nickel company in the late of 1960.The ball mill system consists of one turn disc it rotated 150 rpm and 9 ball are used. They turn disc rotated in one direction and the bowl rotated in opposite direction for they reason of centrifugal force. The centrifugal force created, by the rotation of the bowl around its own axis together with the rotation of turn disc rotated in opposite direction. Normally a jar is made up of stainless steel and coated with aluminum. At the initial stage of ball milling, the powder particles are spread along the jar and set the RPM value as 150. At the intermediate stage of the ball milling size of the Nano particle is significant change compare to the initial stage of rotation. At the final stage of ball milling process considerable refinement and reduction of particle size is obtained. Normally a process carrying out is more than 7 hours are involved it to achieved the fine Nano particle size. After they end of the process the dispose of the Nano particle from the jar with the help of glass plate and spoon

Fig.2. high energy ball miller

CALCULATION

1. AT THE INITIAL POINT A VELOCITY
   Mgcosα=mv2/r
   Where
   V=velocity of ball motion
   M= mass quality
   G=gravity
   R=ball radius
   V=nπR/30
   =300×3.14×10/30
   =314m/sec.
2. At after rotated it angles is
   Mgcosα=mv2/r
   0.0155×9.81×cosα=0.0155× (314)2/10
   α=25 degree 50 seconds
3. Critical speed

   NC=30/√R
   =30/√10
   =9.489 m/sec
4. Then mill speed ratio

   $\emptyset=\sqrt{\cos \propto}$

   $\emptyset=\sqrt{\cos(25\ degree)}=0.9847$
5. Kinetic energy

   =1/2×m×v^2
   =1/2×0.0155× (314) ^2
   =764.119 J

2.3 ULTRASONIC CLEANER

Ultrasonic cleaning is the rapid and complete removal of contaminants from object by immersing mixing of Nano particle and oil mixed in the correct ratio in a tank of liquid flooded with a high frequency sound wave. These non-audible sound waves create a scrubbing brush action within the fluid. They process is carried out involved in a beaker is immersed in water then a high frequency of electrical energy is converted into transducer into high frequency sound wave-ultrasonic energy. A high frequency sound wave is passed through a beaker solution then this ultrasonic wave are passed in every corner of this set up so it is mixed with correct ratio of oil and Nano particle. In every 15 minutes cleaner up the ultrasonic cleaner because temperature of the fluid is varied.

There are many variables consider during a ultrasonic cleaner process like Heat, power, frequency, mixing time, all the phenemenon are included in this process.

Fig.3.ultrasonic cleaner

Fig.4 process involved in ultrasonic wave

3. RESULT AND DISCUSSION

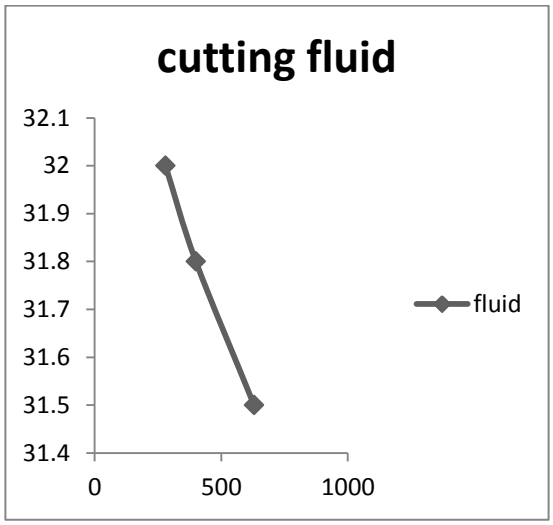
3.1 MACHINING PERFORMANCE INVOLVING A NORMAL COOLANT OIL

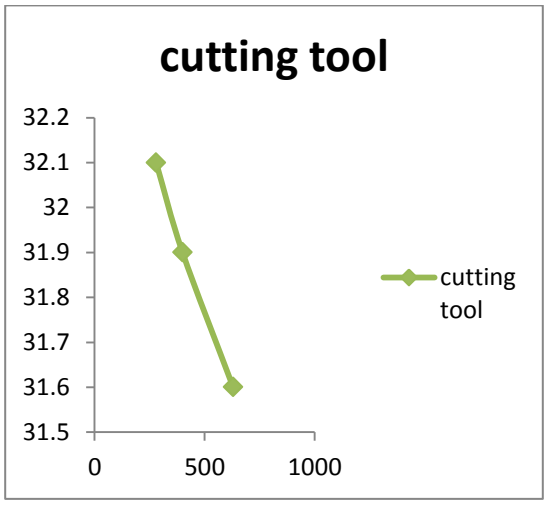
ALL GEAR lathe are used to throughout the experiment for monitoring the process involving a different set of RPM and depth of cut value. Table 3 shows the different set of R.P.M and depth of cut value using normal coolant oil. In this first experimental a normal coolant oil are used it generated large amount of heat Then after it continued they process tool became blunt. Hence, the heat generated in the Turning zone will be much higher after each pass conducted. It entirely changed the work piece properties and structure so normal coolant oil are not effectively reduced they temperature of work piece.

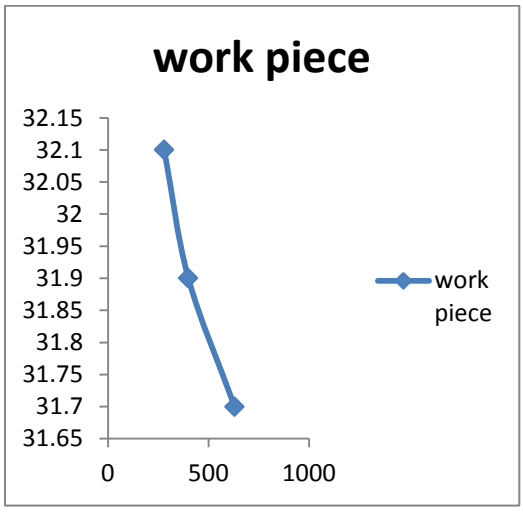
Table 3 MACHINING PERFORMANCE INVOLVING NORMAL COOLANTOIL

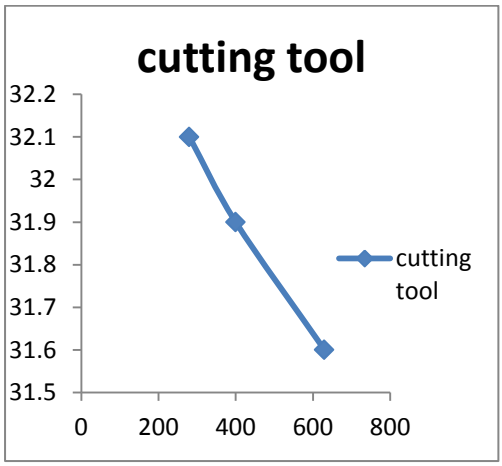
	SPINDLE SPEED (rpm)	DEPTH OF CUT (mm)	TEMPERATURE (CELSIUS)		
			CUTTING TOOL	WORK PIECE	FLUID
1	630	0.4	35.20	35.10	35.20
2	400	0.4	34.50	34.50	34.50
3	280	0.4	34.30	34.30	34.30

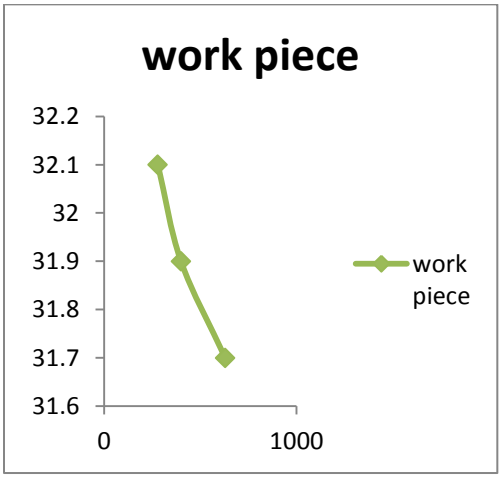
Fig 5.GRAPHICAL REPRESENTATION TEMPERATURE VS RPM











3.2 MACHINING PERFORMANCE INVOLVING A NANO PARTICLE IS MIXED WITH COOLANT OIL

A normal machining process involving it produced a lot heat then it changes the work piece structure and properties. They best solution is involving to overcome the problem reduce the heat of cutting tool, work piece, fluid temperature. So it prefers Nano based coolant fluid it mixed with correct radio of Nano particle and cutting fluid. Table 4 shows the different set of R.P.M and depth of cut value using normal coolant oil.

Table 4 MACHINING PERFORMANCE INVOLVING A NANO PARTICLE IS MIXED WITH COOLANT OIL

S. NO	SPINDLE SPEED (rpm)	DEPTH OF CUT (mm)	TEMPERATURE (CELSIUS)		
			CUTTING TOOL	WORK PIECE	COOLANT
1	630	0.4	31.60	31.70	31.50
2	400	0.4	31.90	31.90	31.80
3	280	0.4	32.10	32.10	32.00

Fig 6.GRAPHICAL REPRESENTATION TEMPERATURE VS RPM

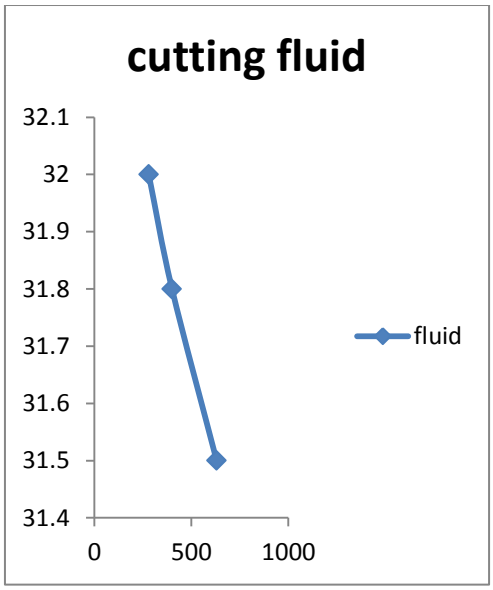


Fig 5 and 6 graphical representation of temperature variation of normal coolant oil and Nano based coolant oil. In normal coolant oil it produced large amount of heat then compared to Nano based coolant oil because ZnO melting point as 1970itcarries a large amount of heat. Figure 6 also shows some sudden drops in the temperature when conducting the turning experiment with metal oxide-based ZnO Nano coolant. This is due to the high thermal conductivity of the Nanoparticles which flow away from the heat from the cutting zone, so avoiding a huge amount of heat penetrating into the work piece during the Turning experiment.

3.3 SURFACE ROUGHNESS TESTING:

The surface roughness of the work piece (mild steel) is determined by surface roughness tester. The tester having a diamond probe at the bottom moves forward and backward along the surface to determine the surface roughness. To eliminate the error in the instrument a calibration is done initially with a standard work piece and then the readings are taken.

WORKING:

Mild steel is machined by turning operation at a speed of 630RPM and depth of feed of 0.4. One side of the work piece is machined with a normal lubricant and the other side with Nano lubricants (ZnO+oil). The Surface roughness of both sides of the work piece is measured by surface roughness tester and the readings are tabulated as follows. The result indicates that with use of Nano lubricants (ZnO+oil) the surface roughness is less when compared to normal oils. The results are plotted in a graph

3.4 ZETA POTENTIAL ANALYSIS

Zeta potential analysis is a simple method to identify the stability of the Nano particles during colloidal dispersion it created a potential difference between the stationary layer and dispersion medium of the particle. Then lower value indicated (positive or negative) stability of Nano particle is very low whenever is applied a minimum load it loses the stability property. Then higher value indicated (positive or negative) zeta potential is very high it only disperse it applied a heavy force. In general value of 25 mv (positive or negative) it taken as the reference value of zinc oxide mixed with coolant oil.

Measurement Results

Zinc Oxide_0054.nzt

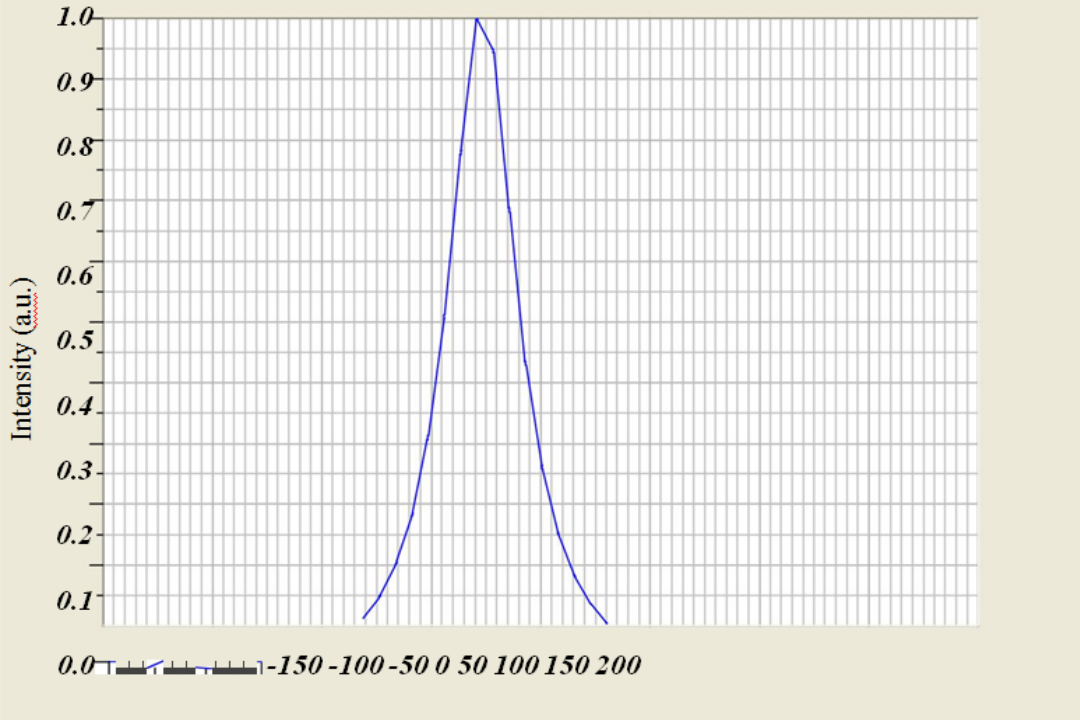
Measurement Results

Date	: Friday, October 07, 2016 2:43:26 PM
Measurement Type	: Zeta Potential
Sample Name	: Zinc Oxide
Temperature of the holder	: 25.1 °C
Viscosity of the dispersion medium	: 0.893 mPa·s
Conductivity	: 0.119 mS/cm
Electrode Voltage	: 3.4 V

Calculation Results

Peak No.	Zeta Potential	Electrophoretic Mobility
1	-26.5 mV	-0.000206 cm2/Vs
2	--- mV	--- cm2/Vs
3	--- mV	--- cm2/Vs

Zeta Potential (Mean)	: -26.5 mV
Electrophoretic Mobility mean	: -0.000206 cm^2/Vs



ZETA POTENTIAL

4. CONCLUSION

This research describes the lubrication mechanisms of advanced metal oxide based zinc oxide as a new coolant for turning process based on minimum quantity lubrication method. Then this method reduce they many problem faced in company like cost, property and structural change of the material, environmental safety, and worker health problem.

On the basis of result obtained after achieved a turning process using a Nano based cutting fluid like temperature, surface roughness value.

1. The result demonstrated temperature of Nano based cutting fluid is lower than normal coolant oil because Nano based coolant oil it contains zinc oxide it absorbs large amount of heat

2. Nano particle and oil are mixed with correct ratio so it obtains a Homogeneous suspension of Nano particle.

3. When ZnO based Nano particle play important role in turning process it reduces the tool wear behavior of the material then to compared using normal coolant oil.

4. A good surface finish is achieved when it to use a Nano based cutting fluid then to compare normal coolant oil. In this tribological contains they Nano particle may fill up the gap of the work piece and cutting tool

5. Zinc oxide has under the 30 d-block element of group-12 and period-4.Then nature of d-block element have good thermal conductivity so I have preferred zinc oxide.

6. Zinc atoms have an electronic configuration of $[Ar]3d^{10}4s^2$. When compounds in the +2 oxidation state are formed the *s* electrons are lost.

7. Zinc play important role for both human and other living things so it is an ECO FRIENDLY then compared to other element. All of the human want minimum 2.5% of the zinc in the body.

REFERENCE

1. Archit Bimal Shah, Karan Kothari, P.M. Anil. "A Comparative Study on the Tribological Performance of Lubricating Oils with ZrO2, CuO and ZnO Nanoparticles as Additives", ISSN 0973-4562 Vol 10 No.91 (2015).

2. M. Gulzar ,H. H. Masjuki ,M. A. Kalam, M. Varman. N. W. M. Zulkifli, R. A. Mufti . Rehan Zahid."Tribological performance of nanoparticles as lubricating oil additives", DOI 10.1007/s110551-016-3537-4.
3. M.Yogeswaran, K. Kadirgama, M.M. Rahman and R. Devarajan."TEMPERATURE ANALYSIS WHEN USING ETHYLENE-GLYCOL-BASED TIO2 AS A NEW COOLANT FOR MILLING", ISSN 2180-1606 Vol 11, pp 2272-2281,January-June 2015.
4. Yousef Shokoohi, Ehsan Khosrojerdi ,B.h. Rassolian Shiadhi "Machining and ecological effects of a new developed cutting fluid in combination with different cooling techniques on turning operation", journal of cleaner production 94(2015) 330-339.
5. Guo-Sheng Su , Yan-Kuo Guo , Xue-Li Song , Heng Tao "Effects of high-pressure cutting fluid with different jetting paths on tool wear in cutting compacted graphite iron", Tribology international 103(2016) 289-297.
6. Dinesh Setti, Sudarasan Ghosh, and P. Venkateswara Rao "Application of Nano Cutting Fluid under Minimum Quantity Lubrication (MQL) Technique to Improve Grinding of Ti – 6Al – 4V Alloy", vol:6 2012-10-24.
7. M.Amritaa, S.A.Shariqa, Manoja, Charan gopala "Experimental investigation on application of emulsifier oil based Nano cutting fluids in metal cutting process", procedia engineering 97(2014)115-124.
8. T. Rajmohan , S.D.Sathishkumar,K.Palanikumar and S.Ranganathan "Modeling and analysis of cutting force in turning of AISI 316L Stainless Steel (SS) under Nano cutting environment", Vol 766-767(2015) pp949-955(2015),doi:10.4028
9. K.P.Sodavadia and A.H. Makwana "Experimental Investigation on the Performance of Coconut oil Based Nano Fluid as Lubricants during Turning of AISI 304 Austenitic Stainless Steel", ISSN 2250-3234 Vol 4 number 1(2014),pp55-60
10. K.S.Srikanth, Jaisankarv, Jores.Svasisht, "Evaluation of tool wear & surface finish of AISI 316L stainless steel using nano cutting environment", ISSN 2320-2092