International Journal on Recent Researches In Science, Engineering & Technology
(Division of Mechanical Engineering)
A Journal Established in early 2000 as National journal and upgraded to International journal in 2013 and is in existence for the last 10 years. It is run by Retired Professors from NIT, Trichy.
It is an absolutely free (No processing charges, No publishing charges etc) Journal Indexed in JIR, DIIF and SJIF.
Research Paper
Available online at: www.jrrset.com

ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105

Volume 4, Issue 10, October 2016

JIR IF : 2.54
DIIF IF :1.46
SJIF IF: 1.329

A Study of Minimum Quantity Lubrication with Nano Cutting Fluid on Surface Roughness and Chip Thickness in Turning Inconel 718

R. Anburaj[(1)]
[(1)]Research scholar,
Department of Mechanical Engineering
Pondicherry Engineering College,
Puducherry, India.
raj.tvlm@gmail.com

Dr. R. Elansezhian[(2)]
[(2)]Associate Professor,
Department of Mechanical Engineering,
Pondicherry Engineering College,
Puducherry, India.
elansezhianr@pec.edu

Abstract

Conventional cutting fluid in metal cutting operation causes health problems, poor machining, heat generation and increased cost of production. Generally, the lubricant cost contributes 15 % of the total production cost. Hence an attempt is made in this paper to experimentally investigation the effect of nano additives in the lubrication system. A system called as Minimum Quantity Lubrication system is proposed in this paper. It essentially means, micro lubrication almost near dry machining. It is the latest technique of sharply delivering cutting fluids at the point of cutting at microlevel. It finally ends-up a little fluid, properly selected and applied resulting in a substantial difference in the performance of the metal cutting operation. The major contribution of the present work lies in suggesting adding nano additives in engine oil in order tominimizethe total production cost and resulting in acceptable surface finish of the work piece, reduced chip thickness and improved production rate.

Keywords: Nano fluids, Roughness, Chip thickness, Inconel 718, Turning.

1.0 Introduction

In machining, the purpose of cutting fluid is to provide cooling and lubrication. But the cutting fluid causes skin problems, cancer to the workers and pollute the environment. Minimum Quantity Lubrication is the one of the latest method improving the machining process in which SAE20W40 engine oil mixed with air supplied at the machining zone under certain flow rate

with a pressure of 5-7 bar (1-4). MQL improves the machining efficiency such as surface quality, less tool wear and good chip breaking. The performance of MQL technique enhance machinability by dispersing nanoparticles in fluid. These nano fluids possessing high thermal conductivity and hence improve the thermal properties of these conventional heat transfer fluids. Nano cutting fluids in which the nano particles are dispersed in base oil (5). The effect of inclusion of nano particles in milling found reduced temperature and cutting force (6). Use of nano boric acid in SAE-40 and coconut oil reduces surface roughness, temperature and tool wear in turning with carbide tool (7). The use of nanographite inclusions to the cutting fluid increases better performance of fluid by increasing the percentage increase in inclusion and machining process. The effect of MQL application of water-based nano fluids and oil based nano fluids significant improvement in overall grinding performance while grinding cast iron. Using nanofluid in MQL for micro-drilling process increases the number of drilling and reduces the torque and forces. It also removed chips and burns to improve the quality of machining(8). MoS_2, diamond and Al_2O_3 nanoparticles in vegetable oil in near dry grinding decreases cutting force with the volume of fraction of 1.5 % nano particles. Influence of MQL lubrication with nano Al_2O_3 increases the surface quality of Inconel 600 with increase in volume fraction (9). Applications of Al_2O_3 nanofluids and nano diamond fluid to micro grinding, Al_2O_3 causes the surface roughness and increased grinding force than nano diamond fluid. Water based Al_2O_3 nanofluid in grinding AISI 52100 steel causes better lubricating properties. Grinding temperature and grinding forces are reduced and surface roughness was improved in the nano cutting fluid environment(11). A Silicon dioxide base nano fluids used in MQLleast amount of tool wear with a nano particle concentration of 0.5 % with pressure 2 bar and better surface finish was obtained with 0.5 % nano particles with lesser air pressure.SiO nano fluid with SAE20W40 in MQL at optimum cutting parameters decreases surface roughness, chip thickness and increased microhardness.(12). High speed end-milling of AISI D3 steel with MQL can reduce thermal cracks and increased tool life.

2.0 Experimental Procedure

2.1 Inconel 718 material

Inconel 718 was selected as a workpiece which is a nickel based alloy widely used in Nuclear reactor, cryogenic applications, the air crafts and in hot section of gas turbines due to their high temperature strength and high corrosion resistance. Dimension of the work piece is 20 mm diameter and 250 mm long. It is divided into 10 equal parts of length 20 mm. The chemical composition of Inconel is 51.76 % Ni, 17.45 % Cr, 3.12 % Mo, 5.02% Nb, 0.77 % Ti, 0.32 % Al, 0.22% Mn, 0.199% Si, 0.041% C, Remaining % Fe. These Nickel-based alloys are very difficult to cut due to its high strength, high abrasive carbide particles, work hardening tendency, strong tendency to weld and form built up edge (BUE) and low thermal conductivity. The machine tool used is kirloskar 10 Hp Lathe. The Turing carried out by TiN coated W-C tool with an optimum parameters of speed 1600 rpm, 2mm/rev and 0.75 mm depth of cut.

The experiment carried out for dry, wet, pure MQL, MQL with 0.75 %, 1 %, 1.5 % of Al_2O_3 and 0.01 % SDS, MQL with 0.75 %, 1%, 1.5% of ZnO and 0.01 % SDS dispersed in SAE20W40 when turning Inconel 718 are compared.

2.2 Advantages of MQL

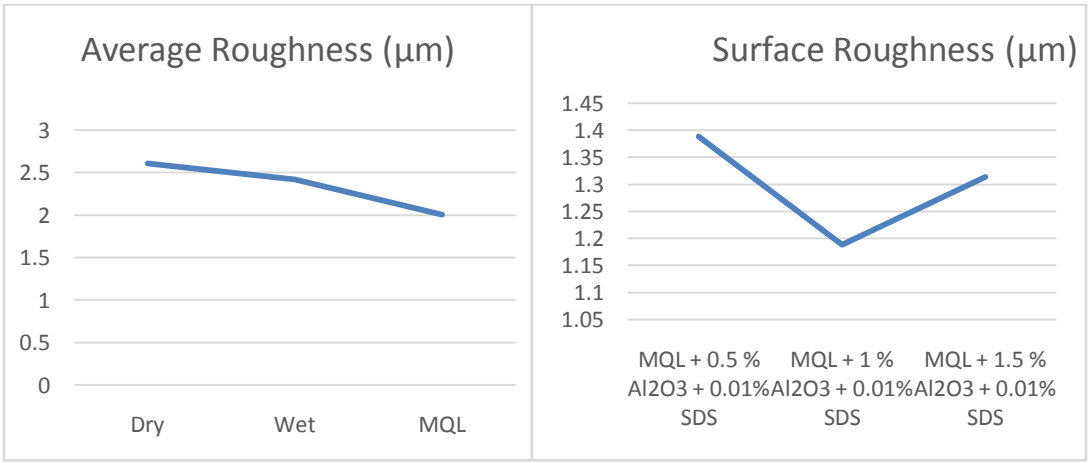
MQL technique is the latest technique suggested by researchers offers many advantages than conventional flood machining and wet machining. It improves tool life, surface roughness, reduced cutting temperature, cutting force and good chip breaking in turning, drilling, milling, etc. Some of the advantages of MQL machining are,

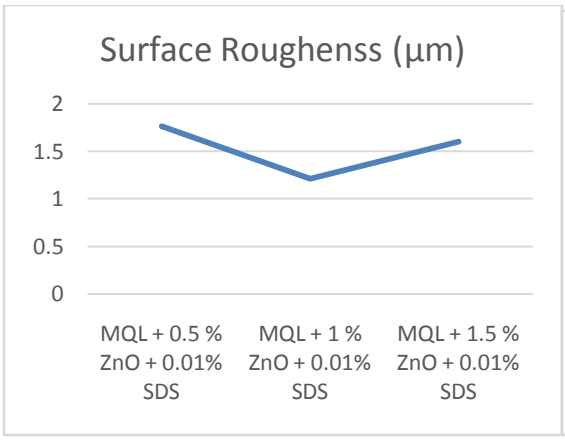
- It reduces less amount of cutting fluid over conventional flood lubrication almost dry machining.
- It is suitable for unenclosed machines like milling machine or lathe due to less mist and spray formation.
- Reduces cutting temperature between tool-work piece interfaces.
- Reduces tool wear while machining hard material.
- The cost of buying and disposing of lubrication is less.

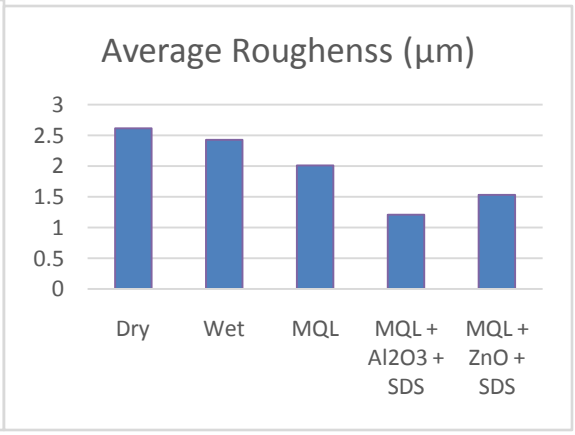
3.0 Results and discussions

3.1 Surface roughness

Surface roughness is the one of the measure of the texture in performing machining. Therefore measuring surface roughness is important. The value is large, the surface is rough if they are small the surface is smooth. Surface roughness determines how the work piece react with environment, rough surfaces wear quickly and have high friction coefficient. It is a good predictor for the performance of components, due to adhesion the formation of crack and corrosion. The average surface value (Ra) measured and compared.

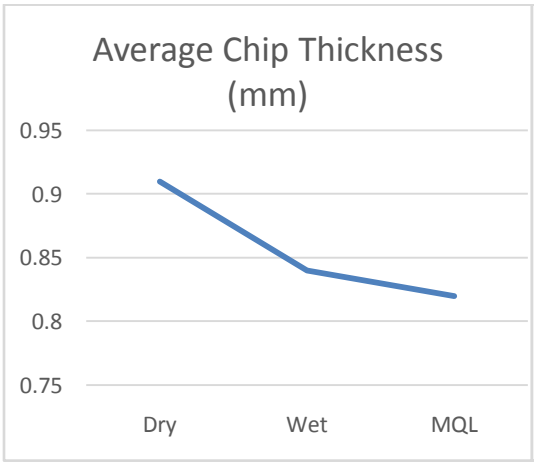


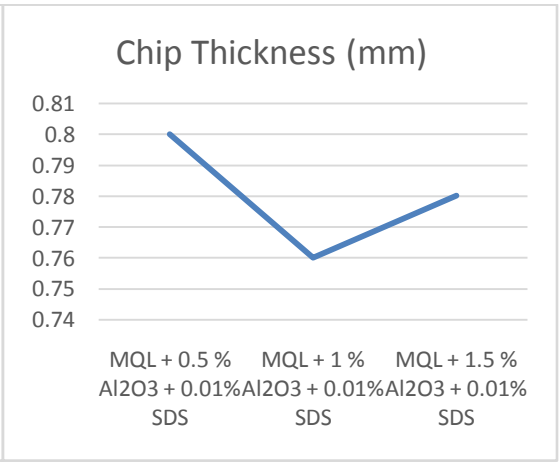


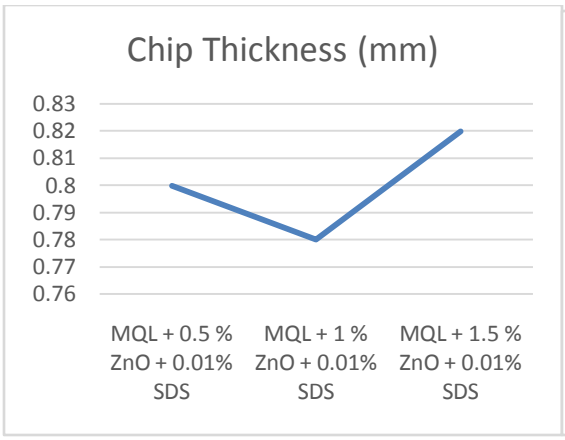


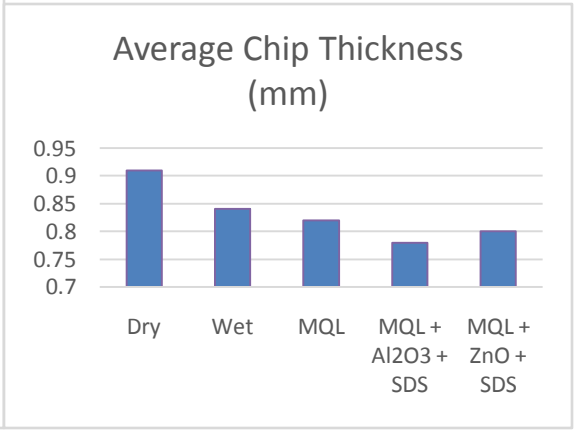
3.2 Chip thickness

Dry machining of difficult to cut materials produces high temperature in between tool and work piece and chip and work piece interface-causes thermal softening and forms continuous helical chip. These chips try to weld on the top of the tool rake face and makes high chip thickness. While machining with conventional cutting fluid, the hydrodynamic fluid layer is formed in between chip and tool rake face and this layer removes the chip away from the rake face. The chip formation is semilong with more helix angle. Machining with Nano cutting fluid, due to dispersion of nano particles break the long chips into small segmental chips. Due to better cooling and lubricating properties of nano-cutting fluid reduces crater wear and sticking of the tool material on the back side of the chip. So the chip thickness is lesser than dry and wet machining.









4.0 Conclusion

The major contribution of this present work, the study compares the performance of dry machining and machining with MQL and MQL with nano cutting fluid.

The various conclusions drawn out of this present work consists of

- The study resulted in significant improvement in productivity, overall machining economy, longer tool life, better chip breaking, better work surface finish, better environmental safer.
- The cost of the lubricant is drastically reduced by 20 % under conventional cutting conditions.
- It is found that 1 % of Al_2O_3 particles and 0.01 % SDS surfactant into the base oil SAE20W40 through MQL mode enhances its machinability characteristics compared to dry and MQL machining.
- The surface roughness is reduced by about 15 % by using nano fluid compared with dry machining and around 10 % wet machining.
- There is a reduction of approximately 30 % in chip thickness while machining nano cutting fluid than other machining.
- The chip morphology shows that good chip breaking occured when nano cutting fluid is used.

References

1. Hadi M. Investigation on turning of AISIH13 with applying minimum quantity lubricant, Indian Journal of Science and Technology, 2013; 6 (2); 4094-7
2. Obikawa T Machining with least quantity lubrication, Advanced Machining Technologies, 2014; 11:255-281
3. Liao YS, Lin HM and Chen YC, Feasibility study of the minimum steely by coated carbide tool, International Journal of Machine Tools and Manufacture, 2007; 47-1667-76
4. Nam JS, Lee P-H and Lee SW, Experimental characterization of micro-drilling process using nanofluids minimum quantity lubrication, International Journal of Machine Tools and Manufacture, 2011; 51;649-52
5. Rahmati B, Sarhan A.A and Sayuti M (2014), Investing the optimum MoS_2 nano lubrication parameters in CNC milling of AL6061-T6 alloy, The International Journal of Advanced Manufacturing Technology.
6. Vasmi Krishna P, Srikant R.R and Nageswara Rao D (2010), Experimental investigation on the performance of nanoboric and suspensions in SAE-40 and coconut oil during turning of AISI 1040 steel, IJOMTM, 50 (10), 911-916
7. Prasad M.M.S and Srikant R.R, Performance evalution of nanographite inclusions in cutting fluids with MQL technique in turning of AISI 1040 steel, 381-393
8. Vasu V, Reddy GPK. Effect of MQL with Al_2O_3 nano particles on surface roughness, tool wear and temperature dissipations in machining Inconel 600 alloy, Journal of Nano Engineering and Nano System, 2011; 225 (1): 3-16.
9. Lee P.H, Nam J.S, Li C and Lee S.W, An experimental study on micro-grinding process with nanofluid minimum quantity lubrication, International Journal of Precision Engineering and Manufacture, 2012; 13 (3); 331-338
10. Saravana Kumar N, Prabu L and Karthik M, Experimental analysis on cutting fluid dispersed with silver nano particles, Journal of Mechanical Science and Technology 2014; 28 (2); 645-651
11. Sayuti M, Sarhan A.A and Salem F, Novel uses of SiO_2 nano lubrication system in hard turning process of hardened steel AISI 4140 for less tool wear, surface roughness and oil consumption, Journal of Cleaner Production, 2014; 67; 265-276
12. Mostafa Hadi and Reza Atefi, Effect of MQL lubrication with Gamma-Al_2O_3 nano particles on surface roughness in Milling AISI D3 steel, Indian Journal of Science and Technology, Vol 8 (3), 296-300, 2015