EFFECTS OF MINIMUM QUANTITY LUBRICATION (MQL) WITH NANOPARTICLE IN TURNING PROCESSES: A REVIEW

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Abstract— ***The quality and productivity of machined components is currently of high interest for the industry, not only from the perspective of functionality but also from that of safety. However increasing productivity along with maintaining quality are the contradictory objectives. To obtain this contradictory objectives various lubrication method are used. Minimum quantity lubrication is an alternative to dry and flood lubrication system from the viewpoint of environment, cost and health issues.Fluids with disperse nanoparticles forming a stable colloid and maintaining surface tension that can offer better level of heat transport property at minimum level of dispersion, are known as nano fluids. This paper presents a comprehensive review of some published research works on MQL and MQL with nano particles and their outcomes on various machining operations, such as, turning, milling, grinding etc. From literature review, it has been found that surface roughness, power consumption, nodal temperature, tool wear, friction coefficient and cutting force are most reduce by nano fluid assited minimum quantity lubrication followed by minimum quantity lubrication with conventional fluid and dry machining.***

Key words— ***MQL, nano particles, nano fluids, NDM, turning.***

I. INTRODUCTION

Increasing consciousness for green manufacturing globally and customer concentrate on eco-friendly products has put high pressure on manufacturers and researchers to avoid or minimize the use of cutting fluids. To replace the usage of cutting fluids, several techniques such as, wet machining, cryogenic cooling, Minimum quantity lubrication and solid lubricant assisted machining have been emerge in current years[8]. To enhance the capability of machine tools and to regulate the machining conditions, various kinds of cutting fluids have been utilized in metal cutting .The cutting fluids were found to be enhance machining quality by their cooling and lubrication effect [26].To minimize the extent of heat produced during machining operations large amount of cutting fluid under flood cooling has been comnsumed throughout the world. However, many researchers have criticized the utilization of flood cooling from ecology, economic and social perspective. To minimize the uses of flood cooling lubrication, a method called minimum quantity lubrication (MQL)or near dry machining(NDM)has been develope in in the recent years .Due to the consumption of least amount of cutting fluid the MQL can be selected as the more suitable method as compared to conventional machining [7].

Nano-fluids refer to cutting fluids obtained by dispersing the certain amount of nano-particles in base fluids. When the least amount of nano particles are suspended in base fluids, can improve the thermal conductivity of base fluids. The various types of nano-particles such as Al_2O_3, graphite, Ag,ZnO, diamond, boric and MoS_2 with excellent properties are frequently used to increase the lubricity and heat absorption capability of coolants[4].Fig. 1.1 show the thermal conductivity of nano particles, according to that Ag nano particle consist highest thermal conductivity.

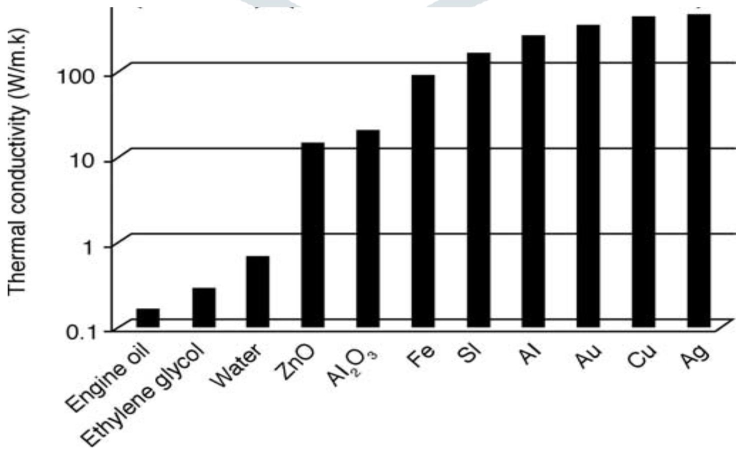

Figure: 1.1 Thermal conductivity comparisons [28]

The environmental, economic, and human health issues related with conventional flood machining have leads researchers to find ways of either reduce the amount of cutting fluids applied in machining or to eliminate the usage od cutting fluid. Minimum quantity lubrication (MQL) can be considered as a effective alternative for conventional flooded machining. In the MQL, a less amount of lubricant atomized in a compressed air (aerosol) flow is supplied to the cutting edge of the tool.In MQL compressed air pressure and fluid flow rate are two major factor which controls the cooling effect.Since a least amount of cutting fluid is used in the MQLso the lubricating ability andits thermal conductivity are not sufficent.Hence the heat-carrying capacity and lubricating ability of the cutting fluids have to be improved. In order to achieve the high cooling and lubricating capability with the MQL, a fluid with high thermal conductivity must be utilized [27].

The traditional methods of increasing the cooling rate have already at their extreme. For the high performance cooling and lubrication utilization of new approaches is essential.Nano particle enriched fluid provides a potential way to fulfill this requirement. Nano fluids have suitable property like high heat transfer performance and thermo-physical properties . Results of the recent researches with nano fluids in machining show the sustainable performance of these fluids as an alternative of the traditional metal working fluids assisted with the MQL technique. The nano fluids having high thermal conductivity and convection heat transfer coefficient due to inclusion of nano particle and the properties are increasing with increasing in nano particle concentration.Nano fluids can be supply to the cutting zone in a machining process through nozzles like the flooded machining systems, but the larger wastage during the machining application and higher manufacturing costs of nano fluids have urged researchers to study nano fluids along with the minimum quantity lubrication system [27].

The main aim of the present study is to understand the mechanism involved in functioning of different nanoparticles mixed in conventional fluids and their effects on turning. This may be helpful in the selection of appropriate nanoparticles type among different available nanoparticles for any specific machining process.

II. MECHANISM OF NANO PARTICLE FUNCTIONING

- Effect of particle volume concentration

Viscosity is also strongly dependent on the concentration of particle dispersion in the base fluid. It has been reported that Nano fluid viscosity in most cases is higher than that of the base fluid. The ratio of viscosity of the Nano fluid to that of the base fluid increases with an increase in particle concentration [28].

- Effects of particle size

The viscosity ratio of Nano fluids decreases with an increase in the size of dispersed particles. However, there are some variations in the literature, where the viscosity ratio has been reported to increase with an increase in particle size , and, in another study, viscosity first increases and then decreases with an increase in particle size for 3.0 vol% Al2O3–propylene glycol Nano fluid [28].

- Effects of Temperature

In general, most studies reported a gradual decrease in the viscosity of Nano fluids as well as that of base fluid with increasing temperature. However, the slope of the curve remains almost identical in the concerned temperature range.Relative viscosity remains nearly constant as a function of temperature for most of the cases [28].

III. LITERATURE REVIEW

Chetan , B.C.Behera, S.Ghosh, P.V.Rao (2016) [1] Investigate and compare the effect of different cooling condition On cutting force , tool wear and surface roughness during turning of Nimonic 90. The cooling condition used for experimentation are minimum quantity lubrication with silver (Ag) and aluminium oxide (Al2O3) nano particle , Sunflower oil in water and dry machining. Preparation of nanofluid was done with the help of Al2O3 nano particle (40nm) was mixed with water 0.1% , 0.5% and 1% Volumetric concentration , Ag nano particle (10nm) with concentration of 0.1mg/ml was available in the form of colloidal mixture. This colloidal mixture adds by 5%, 10% and 15% volumetric concentration in water. For the preparation of bio – degradable emulsion sunflower oil was added to water by 1%,5% and 10% volumetric concentration . Sodium lauryl sulfate was added to nano fluid for maintain or reduce surface tension for better stability of nano fluid. Flow rate for minimum quantity lubrication is at 3 level 60, 120, 250 ml/hr and compressed air pressure is maintain at constant at 4 bar. Nano fluids had used for machining of nickel alloy. Result got was compared with biodegradable emulsion and dry machining. The conclusion from result so got clarified that use of Ag nano fluid resulted in good surface finish and reduced abrasion wear and for rack face wear Al2O3 nano fluid was proven best. The lowest magnitude of cutting force, surface roughness & tool wear has benn found with Al2O3 nano fluid at 125 ml/hr.

Radoslaw W. Maruda, Grzegorz M. Krolczyk, Eugene Feldshtein, Piotr Nieslony, Bozena Tyliszczak, Franci Pusavec (2016) [2] studied the effect of minimum quantity lubrication , dry machining and minimum quantity lubrication with ester based additives on tool wear during turning of AISI 1045 carbon steel. Cutting tool insert used during the experimentation was SNUN 120408 coated carbide insert with grade P25 along with tool holder ISO- CSDBM2020-M12. It was observed that flank wear mainly depend on material removed volume. In comparison of cooling condition flank wear and crater wear measured maximum in dry machining and then followed by MQL and MQL with phosphate ester based additives. VBmax was measured 0.6 mm. In the case of small droplet size (Davg = 8.53µm) value of VBmax and KT was reduce by 17% and 10% respectively compare to large droplet size (Davg = 22.72 µm). The decrease of the KB crater width with the use of minimum quantity lubrication with ester based additives method compared with dry machining was from 6.2% for a cutting speed of 250 m/min to 22% for cutting speeds of 350 m/min and 450 m/min. KE indicator for cutting speed 250 m/min for all cooling methods not exceed more than 0.005 mm.

R. Deepak Joel Johnson, K. Leo Dev Wins, Anil Raj, B. Anuja Beatrice [3] propose study compare the cooling condition (MQL, dry and wet machining) on surface quality during turning of oil hardened non shrinkable steel (OHNS) had hardness 34 HRC. The cutting tool used during turning was SNMG 120404 along with tool holder PSBNR2525M12. Design of experiment was made with the help of Taguchi. Taguchi method uses the S/N ratio to measure the quality characteristic deviating from the desired value. According to taguchi analysis it was concluded that feed rate and depth of cut was most significant parameter for surface roughness. ANOVA analysis was carried out to identify the relative significance of individual parameters on surface roughness. From the ANOVA it was concluded that feed rate (p-0.002) was most significant parameter for surface roughness. The model was sufficiently accurate because the R2 and R2(adj) value was 96.36% and 97.28% respectively. The optimum value of input parameter to minimize surface roughness was determined by response optimizer. Optimum value of input parameter as follow: cutting speed 148.44 mm/min, feed rate 0.06 mm/rev, depth of cut 0.5mm, flow rate 6 ml/min.

Anuj Kumar Sharma, Rabesh Kumar Singh, Amit Rai Dixit, Arun Kumar Tiwari (2016) [4] Studied the effect of Al2O3 nano particle based cutting fluid on cutting force , tool wear, surface roughness and chip morphology during turning of AISI 1040 steel with the help of cemented carbide insert. The response parameters are compare with dry machining, minimum quantity lubrication with conventional fluid and wet machining. The response parameter cutting force , tool wear and surface roughness was measured with the help of kistler dynamometer, Olympus BX51M microscope and Mitutoyo surftest SJ – 210 respectively. The nano fluid was prepared by mixing Al2O3 nano particle in different volumetric concentration of 0.25%, 0.5%,1.0%, 1.5% , 2% and 3% to vegetable oil water emulsion to obtain uniform dispersion nano fluid kept under ultrasonic vibration for 6 hours. From the investigation it was concluded that with the use of nano fluid 59.1%, 29.2% and 28.6% reduction in cutting force compare to dry machining, wet machining and MQL with conventional fluid respectively. Tool wear was reduce by 63.9%, 44.9% and 5.27% with the use of nano fluid ,compare to dry machining , wet machining and MQL with conventional fluid respectively. Surface roughness was reduce by 47.8%, 29.1% and 25.5% with the use of nano fluid ,compare to dry machining , wet machining and MQL with conventional fluid respectively. Viscosity, thermal conductivity and density of nanofluids are improved with increase of nanoparticle concentration while specific heat is reduce with increase of nanoparticle concentrations.

Vincenzo Tebaldo , Giovanna Gautier di Confiengo , Maria Giulia Faga (2016) [5] Studied the effect of eco-friendly (MQL) lubrication system on tool life, surface roughness and machining cost during turning of Inconel 718. Heat treatment process was done on the work piece to improve hardness up to 415HB. Cutting tool selected for the better surface quality and tool life was RCMT1204MO-SM-S05F along with tool holder micron SRDCN 3225-12M. In this study 4 types of lubrication system are compared, minimum quantity lubrication, minimum quantity cooling, dry machining and wet machining. For wet machining based fluid used was water based emulsion containing 5 % of soluble oil. LB2000 oil was used as based fluid for minimum quantity lubrication. Flow rate and compressed air pressure was maintain at 0.3 ml/hr and 6 bar respectively. Minimum quantity cooling is done with the help of cryogenic gases. From the study it was concluded that for tool life minimum quantity cooling seems best compare to minimum quantity lubrication ,wet and dry machining. For surface roughness minimum quantity lubrication found best followed by minimum quantity cooling, wet and dry machining.

Armando Marques, Cleudes Guimaraes, Rosemar Batista da Silva, Maria da Penha Cindra Fonseca, Wisley Falco Sales, Álisson Rocha Machado (2016) [6] Investigate the effect of graphite and MoS2 solid fluid on surface roughness , tool life , residual stress, micro structure and micro hardness during turning of Inconle 718 with minimum quantity lubrication. For MQL parameters – flow rate 40ml/hr, compressed air pressure 0.5 MPA. The solid particle size for MoS2 was 6 µm and for graphite 24 – 27 µm. The cutting tool used for turning was SNMG 120408-SM and tool holder PSBNR2525 M12. MQL (Vegetable oil + 20% graphite) resulted in 17% and 4% increase in tool life compare to MQL (Vegetable oil + 20% MoS2) and pure oil. The Ra value was varied between 0.4 to 0.95 µm for all cooling environment but the best surface quality achieved with the utilization of graphite solid particle. Micro hardness with more regular pattern was observed after machining with graphite contained fluid. Residual compressive stress observed after machining with solid particle but no tensile residual stress after machining with graphite particle.

Munish Kumar Gupta, P.K. Sood, Vishal S. Sharma (2016) [7] compare the effect of Al2O3 , MoS2 and graphite based nano fluid on cutting force , tool wear , surface roughness and cutting temperature during turning of titanium (grade 2) alloy. Cutting tool used for machining was CBN insert (CCGW09T304-2). The lubrication fluid flow rate and air pressure was maintain at 30 ml/hr and 5 bar respectively. The measurement of cutting force, tool tip temperature, flank wear and surface roughness with the help of DKM2010 dynamometer, HTC make infrared thermometer, Mitutoyo tool maker microscope & Mitutoyo SJ 301 surftester respectively. Design of experiment was made with the help of Box – behnken using response surface methodology and analyze with the help of ANOVA. Optimization was done with help of PSO and BFO. From this study it was concluded that graphite based nanofluid is best for reducing cutting force , tool wear, cutting temperature and surface roughness due to lower viscosity compare to other two nano fluid.

Uma Maheshwera Reddy Paturi, Yesu Ratnam Maddu, Ramalinga Reddy Maruri, Suresh Kumar Reddy Narala (2016) [8] studied the effect of tungsten disulfide (WS2 – solid particle) assisted minimum quantity lubrication on surface roughness during turning of Inconel 718. In this study compare the surface quality during MQL and MQL with tungsten disulfide solid particle. Cutting tool used during turning was SNMG120408. Based cutting fluid used for MQL was emulsifier oil base cutting fluid with the flow rate of 200 ml/hr. The surface roughness was measured with the help of surftest SJ 301. DOE was selected with the help of taguchi orthogonal array L27 (33). The significance of the parameter or percentage contribution ofinput parameters on the surface roughness was identify with the help of ANOVA and co relation between parameters by multiple regression. From the ANOVA analysis it was concluded that feed rate was most significant parameter in both cooling condition .For both cooling condition optimum value of cutting parameter are same, cutting speed 100 m/min, feed 0.1mm/rev, depth of cut 0.05mm. Surface quality was improved by 35% with the help of WS2 assisted minimum quantity lubrication compare to MQL.

D.M. D'Addona, Sunil J Raykar (2016) [9] investigate the effect of wiper geometry insert on surface quality during turning of OHNS steel. In this study two type of inserts used (a) WNMG060408MT (conventional) (b) WNMG060408WT, WNMG060404 (wiper geometry). Design of experiment was made with the help of Taguchi L36 orthogonal array was selected for experiment and analysis was done by ANOVA. From the ANOVA table it was concluded that for surface roughness feed rate (p- 0.00) was most significant parameter followed by depth of cut (p-0.04) and insert (p-0.05). Surface quality was improved by using wiper geometry insert compare to conventional insert. Optimum value of input parameter nose radius, Cutting speed, feed rate and depth of cut maintain at 1.25mm, 1200RPM, 0.08 mm/rev and 0.1mm respectively for better surface quality

R. Padmini, P. Vamsi Krishna, G. Krishna Mohana Rao (2016) [10] studied the effect of vegetable oil base nano fluids on cutting force, cutting temperature, tool wear and surface roughness during turning of AISI 1040 steel. Cutting tool used for turning was CNMG120408NC6110 along with tool holder PSLNR2020K12. Different nano fluid was made with the help of dispersion of nano molybdenum in coconut (CC), sesame (SS) and canola (CAN) oil. Flow rate of minimum quantity lubrication was maintained at 10ml/min. From the investigation it was concluded that reduction in surface roughness , tool wear, cutting force and temperature by 39%, 44%, 37% and 21% respectively by using CC + nMoS2 at 0.5% npi compare to dry machining. Thermal conductivity, heat transfer coefficient, specific heat and density was improve with increasing in nano particle inclusion for all nano fluid.

A.N.M Khalil, M.A.M Ali, A.I. Azmi (2015) [11] studied the effect of dry machining , MQL with Al2O3 nano particle and MQL with Al2O3 nano particle+ SDBS on tool wear during turning of AISI 1050. Sodium dodecyl benzene sulfate used to reduce the surface tension of nano fluid which helps for stabilization of nano particle in the nano fluid. Nano fluid prepared by mixing Al2O3 nano particle (0.1% by weight) in soluble cutting oil and then ultrasonic vibration processes within 4 hours at 25% amplitude. Surface tension of base fluid was reduce by adding 3% wt SDBS. Cutting parameter like cutting speed (1273 rpm) , feed rate (0.2mm/rev) and depth of cut (0.1mm) remains constant .Minimum quantity lubrication parameters like flow rate 20 ml/hr and compressed air pressure maintain at 6 bar. Flank wear was measured with the help of Leica E24 stereo microscope . From this study it was concluded that flank wear was maximum at dry machining due to low heat dissipation compare to MQL with pure oil and MQL with SDBS.

S. Ekinovic, H. Prcanovic, E. Begovic (2015) [12] studied the effect of the minimum quantity lubrication on cutting force during turning of carbon steel St 52-3. St 52-3 is low carbon and high strength steel. Which hardness of 160 HB an tensile strength of 500 mpa. The cutting tool used during turning was uncoated cemented carbide K10 (ISO IR 3232K10). The fluid used for minimum quantity lubrication was the combination of water and vegetable oil / bio degradable oil. The flow rate for both was 10 to 50 ml/hr and 0.3 to 1.7 l/hr respectively. For the measurement of cutting force KISTLER 5070 dynamometer was used. Result and discussion covers the measurement of cutting force value, it was observed that cutting force magnitude with MQL and without MQL was 517N and 626N respectively. From the investigation it was concluded that 17% reduction in cutting force with the help of MQL. The optimum value for MQL parameters are 10 ml/hr of oil and 1.7 l/hr of water. It was observed that nozzle position was not significantly affected on cutting force.

Mohamed Handawi Saad Elmunafi, D. Kurniawan, M.Y. Noordin (2015) [13] propose study focuses on the effect of MQL using castor oil on cutting force , tool life and surface roughness during turning of AISI420 stainless steel bar with the hardness of 47 – 48 HRC. The cutting tool used during turning was WC-6%WCo substrate cover with PVD TiAIN coating. The air pressure and fluid flow rate were maintain at 5 bar and 50ml/hr respectively. The response parameter cutting force , tool life and surface roughness was measured with the help of Kistler 926B dynamometer, digital microscope (zeiss type stemi 200-c) and mitutoyo SJ – 301 respectively. Response parameter was compare with dry machining. Result and discussion covers that tool wear, cutting force, surface roughness was reducing in MQL with compare to dry machining. From this study it was concluded that tool wear, cutting force, surface roughness was best at low feed 0.16 mm/rev. and low speed 100 m/min.

Ahmadreza Hosseini Tazehkandi, Mohammadreza Shabgard, Farid Pilehvarian (2015) [14] propose study focuses on the effect of MQL and flooded cooling on cutting force , tool tip temperature and surface roughness during turning of Inconel 740. For spray cooling they utilize liquid nitrogen, bio degradable vegetable cutting fluid along with the compressed air. The cutting tool used during turning was CNMG120404 coated carbide along with tool holder PCBNL2020M12. For flooded cooling flow rate was maintain at 40 l/hr and for MQL 80ml/hr combine with air pressure of 700 kpa.From the study it was concluded that cutting force , surface roughness and tool tip temperature during MQL was reduce 34%, 41% and 52% compare to flooded cooling.

D .A. Stephensona, S.J. Skerlos, A.S. King, S.D. Supekar (2014) [15] Propose study focuses on comparison of the effect of water based flood cooling and super critical Co2 based MQL on tool wear nad material removal rate during turning of Inconel 750. In MQL Co2 flow rate was maintain at 550g/min and fluid flow rate were estimated to be 10ml/hr and 15 ml/hr. Cutting tool used during turning was KC5010SNMG543RP coated carbide insert. From the study it was concluded that supercritical Co2 MQL give beter tool life when compare to aques flood coolant. Supercritical Co2 assisted MQL with two flow rate provide 25% and 40% respectively improvement in MRR compare to aques flood cooling. The optimum machining condition for MRR and tool wear was feed rate 0.25 mm/rev, depth of cut 3mm and cutting speed 48.7 SMM.

M.Amrita, S.A.Shariq, Manoj, Charan gopal (2014) [16] propose study compare the effect of five cooling condition on cutting force , cutting temperature, tool wear, surface roughness during turning of AISI1040 steel. The cutting tool used for turning was CNMG120408TTS. Cooling conditions are as follows (a) functionalized nano graphite (b) nano boric acid (c) nano molybdenum disulphide in emulsifier oil assisted MQL (d) dry machining. From the study it was concluded that for cutting force, cutting temperature, tool wear, and surface roughness was best compare to dry or conventional wet machining. For tool wear , cutting force and surface roughness nano molybdenum disulphide in emulsifier oil assisted MQL found to be best compare to other nano fluid . For cutting temperature nano boric acid is found optimum compare to other nano fluid.

Murat Sarıkaya , Abdulkadir Gullu (2014) [17] propose study compare the effect of vegetable oil, mineral oil with synthetic ester and mineral oil assisted MQL on flank wear, notch wear and surface roughness during turning of cobalt base supper alloy Haynes 25 (207 HB). Work piece material comes under DTM (difficult to cut material) . The cutting tool used for turning was SNMG 120408-QM along with tool holder PSBNR2020K-12. Flow rate and compressed air pressure for MQL system are 60,120,180 ml/hr and 6bar respectively. Machining parameter like feed rate (0.15 mm/rev), depth of cut (1mm) were remain constant. Design of experiment made with the help of Taguchi L9 orthogonal array. Surface roughness measured with the help of TIME TR100 profilometer. From the study it was concluded that flank wear, notch wear and surface roughness was minimize in the case of mineral oil with synthetic ester assisted MQL. Main effect analysis was done with Taguchi and percentage contribution done with the help of ANOVA. Optimization of input parameters was obtained from the grey relational analysis and mathematical modeling with the help of response surface methodology. Tool wear and surface roughness was reducing in the case of mineral oil with synthetic ester assisted minimum quantity lubrication compare to other lubrication.

Murat Sarıkaya , Abdulkadir Gullu (2014) [18] propose study compare the effect of MQL, flooded cooling and dry machining on surface roughness during turning of AISI 1050. DOE was made with the help of Taguchi L16 (43*21) orthogonal array. The cutting tool insert used during turning was SNMG120408 (sandvik coromant) along with tool holder PSBNR2020K12. For minimum quantity lubrication flow rate maintain at two level 60ml/hr and 120ml/hr and compressed air pressure 6 bar. ANOVA analysis was done to identify the significance and percentage contribution of input parameter on Ra and Rz. Mathematical modeling was done with the help of response surface methodology. From the investigation it was concluded that cooling condition was highly effected on Ra and Rz with the help of S/N ratio. ANOVA demonstrates that feed rate and cooling condition was highly effective for Ra and Rz. Response surface methodology was used for prediction of response parameter. The error in the prediction was 2.72% and 7.14% for Ra and Rz respectively.

Mohammadjafar Hadad , Banafsheh Sadeghi (2013) [19] propose study compare the effect of cooling condition (MQL, dry and wet machining) on cutting temperature, cutting force and surface roughness during turning of AISI4140 soft steel with the hardness of 340 HV. The cutting tool (HSS tool steel) has been used during experimentation. Minimum quantity lubrication parameters flow rate and compressed air pressure was maintain at 30ml/hr and 3 bar respectively. Fluid used for wet cooling and MQL were water miscible 10%(5 l/min) concentration and ester oil respectively. From the study it was concluded that application of MQL techniques to the turning resulted in a superior to that of conventional method. It was observed that greater the cutting forces the more heat is generated and consequently the higher cutting temperatures.

Y.Kaynak , H.E.Karaca , R.D.Noebe , I.S.Jawahir (2013) [20] propose study compare the effect of minimum quantity lubrication and dry machining on tool wear during turning of NiTi shape memory alloy. A DCGT111308HP grade KC5410 cutting tool insert with TiB2 coating was used in the experiment. The cryogenic coolant was liquid nitrogen, applied under 1.5 MPA pressure and approximately 10 g/s mass flow rate. In MQL metalworking lubricant was used at flow rate 60ml/hr and approximately 0.4 MPA air pressure. From this study it was concluded that cryogenic cooling was give better result in tool wear compare to dry and minimum quantity lubrication.

M.M.A. Khan, M.A.H. Mithu, N.R. Dhar (2009) [21] studied the effects of minimum quantity lubrication (MQL) by vegetable oil based cutting fluid on the turning performance of low alloy steel AISI 9310 as compared to completely dry and wet machining in terms of chip–tool interface temperature, chip formation mode, tool wear and surface roughness. Also conclusion made that the minimum quantity lubrication was provided with a spray of air and vegetable oil. MQL machining was performed much superior compared to the dry and wet machining due to substantial reduction in cutting zone temperature enabling favorable chip formation and chip–tool interaction. It was also seen from the results that the substantial reduction in tool wears resulted in enhanced the tool life and surface finish. Furthermore, MQL provides environment friendliness (maintaining neat, clean and dry working area, avoiding inconvenience and health hazards due to heat, smoke, fumes, gases, etc. and preventing pollution of the surroundings) and improves the machinability characteristics.

Toshiyuki Obikawa , Yuki Asano , Yasuhiro Kamata (2009) [22] propose study compare the effect of different type of nozzle for MQL on flow rate during turning of Inconel 718. The cutting tool used during turning was cemented carbide coated with CVD multilayer of TiCN /Al2O3/TiN (DNMG150404) along with tool holder PDJNR2525. MQL flow rate and pressure were 0.20 to 15 ml/hr and 0.40 MPA respectively. From the study it was concluded that decreasing in distance from the outlet of the nozzle increase pressure and velocity of compressed air resulted in large change in flow rate .cover type nozzle with oblique spraying has largest delivery rate.

V.N. Gaitondea, S.R. Karnik, J. Paulo Davim (2008) [23] propose study determined the optimum MQL and machining parameter during turning of CuZn39pb3 using k10 carbide tool. Design of experiment was made with the help of Taguchi L8 orthogonal array and analysis has been done with the help of ANOVA. Response parameter like surface roughness and cutting force was measured with the help of "hommelwerker T100" profilometer and kistler piezoelectric dynamometer respectively. Flow rate for MQL was maintained between 50 to 200 ml/hr. From the Taguchi S/N ratio plot it was found that 200ml/hr flow rate, 200 m/min cutting speed and 0.05 mm/rev. was the best optimum condition to minimize surface roughness and cutting force. ANOVA analysis concluded that feed rate was the most significant parameter followed by MQL and cutting speed. Percentage contribution for the feed rate was 89.85%.

Y. Kamata, T. Obikawa (2007) [24] propose study investigate the effect of different coated carbide insert with dry, wet and MQL on tool life and surface roughness during turning of Inconel 718 . They had used 3 coated insert (a) TiAIN (PVD) (b) TiN/AlN superlattice (PVD) (c) TiCN/Al2O3/TiN (CVD). In MQL as abased fluid biodegradable synthetic ester was selected. Flow rate for flooded cooling and MQL was 3.7i/min and 16.8 ml/hr respectively, air pressure was maintained between 0.40 to 0.60 MPA. From the study it was concluded that for dry cutting no significant difference in tool life in comparison of listed 3 insert but for wet and MQL assisted machining TiCN/Al2O3/TiN (CVD) was best for tool life compare to other 2 insert. Response parameter tool life and surface roughness was found best in MQL and wet machining as compared to dry machining. It was observed that surface finis was good in MQL as compared to wet machining cut tool life was observed best in wet machining.

N.R. Dhar , M.W. Islam , S. Islam , M.A.H. Mithu (2006) [25] propose study investigate the influence of MQL on cutting temperature, chip and dimensional accuracy in turning of AISI1040 steel. The response parameter was compared with dry and wet machining. Cutting tool used during turning was SNMM120408 along with tool holder PSBNR2525MI12. For MQL flow rate of fluid was maintained at 60 ml/hr and compressed air pressure at 7 bar. The fluid has been used for lubrication was soluble oil. From the study it was concluded that MQL provide advantage mainly by decreasing the cutting temperature which leads to maintain sharpness of the tool. Dimensional accuracy improved mainly due to reduction of wear at the tool tip with the help of MQL.

IV. SUMMARY

With the help of literature review we can say that, the nanoparticle contained cutting fluid exhibits better tribological properties compared to its base fluid. Most of the experimental studies showed that tribological properties improved with increasing concentration of nano particles in base fluid. Also, the inclusion of Nano particles in cutting fluids showed a reduction in power consumption, specific energy, cutting force, surface roughness, nodal temperature, tool wear (flank & crater) and friction coefficient during machining. Furthermore, an increase of Nano particle concentration reduced the cutting force, friction coefficient and nodal temperature. Due to application of nanoparticle enriched cutting fluids (Nano fluids), it causes increase of thrust force and better surface roughness in experiments.

V. RECOMANDATION FOR FUTURE WORK

Till now, very less work is done on Inconel 750 so we can use MQL (Nano fluid) to enhance machining property of this nickel alloys. Machining performance can be improved by using hybrid nano.Further investigation can also be focused on combinations of different nanoparticles and base fluids during machining of different metals and alloys.

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