TOOL WEAR ANALYSIS BY USING ECO-FRIENDLY COCONUT OIL WITH SUSPENDED BORIC ACID POWDER AS COOLANT FOR MACHINING OF ALUMINIUM 7075 ALLOY

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CERTIFICATE

I hereby certify that the work being presented in the dissertation entitled "Tool Wear Analysis By Using Eco-Friendly Coconut Oil With Suspended Boric Acid Powder As Coolant For Machining Of Aluminium 7075 Alloy" in partial fulfillment of the requirement of the award of the Degree of master of technology and submitted to the Department of Mechanical Engineering of Lovely Professional University, Phagwara, is an authentic record of my own work carried out under the supervision of Mr Anil Baliram Ghubade Department of Mechanical Engineering, Lovely Professional University. The matter embodied in this dissertation has not been submitted in part or full to any other University or Institute for the award of any degree.

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Signature of Examiner

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"The true method of knowledge is experiment."

— William Blake

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(Akshaykumar Kiranbhai Vadaliya)

ABSTRACT

In manufacturing, the most promising technique is machining to obtain good surface finish and quality in the final part. Various methods are currently being use to improve the surface finish like use of cutting fluids, selection of tools etc. Although the use of cutting fluids like synthetic fluids, emulsions, vegetable oils, etc gives proper surface finish. But recently reported use of nano particles with cutting fluids give us improved results. Conventional cutting fluids used in machining threatens ecology and health of the workers. Considerable research is being done in this field where such cutting fluids are being used which are effective as well as eco-friendly for both humans and environment. In this paper work is done using boric acid powder with coconut oil as fluid which have considerable effect on surface finish of work piece as well as tool life in machining of Aluminium alloy 7075 with its eco-friendly nature.

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1. INTRODUCTION:

Metalworking fluids (MWFs), are utilized widely in machining process, are one of the sorts of lubricating components. There are various sorts of MWFs which might be utilized to complete such operations. The majority of the Metal Working fluids (MWFs) are mineral oil-based liquids which increment effectiveness and the product quality by cooling and greasing up metal removal zones. Because of the advantages ,the admission of Metal Working fluids (MWFs) is expanding in manufacturing. It is accounted for that the European Union only expends approximately 320 million kilograms every time of Metal Working fluids (MWFs) out of which no less than 66% should be arranged. In spite of their boundless utilize, they posture huge wellbeing and ecological dangers for the duration of their life cycle. It is accounted for that around 80% of every single word related sickness of administrators were because of skin contact with cutting liquids. Evaluation demonstrates that in the United States of America alone around 700,000 to one million specialists are presented to Metal Working fluids (MWFs).

As cutting liquids are unpredictable in their chemical structure, they may cause aggravation or response. Microbial poisons are additionally created by microorganisms and parasites show, especially in water-solvent cutting liquids, and they are exceptionally unsafe to the administrators. To conquer these troubles, different replacements to oil based Metal Working fluids (MWFs) are as of now being investigated by researchers and tribologists. Such options incorporate engineered oils, strong greases and vegetable-based oils. The developing interest for recyclable materials has opened a road for utilizing vegetable oils as a contrasting option to oil based polymers, most particularly in machining operations. Greases are utilized as a part of many shifted ranges; in this manner, their natural suitability has turned out to be progressively imperative. Therefore, look into on bio de-gradable practical liquids developed as one of the best needs in grease in the mid 90s, which prompted a great deal of developing number of earth amicable liquids and ointments in the arcade.

Vegetable oils, particularly rapeseed & canola are a portion of the all the more encouraging applicants as base stocks for the recyclable oils. They are effortlessly biodegradable and more affordable than engineered base stocks. They frequently indicate very agreeable execution as lubricating medium. Cutting liquids are by and

large ordered into three principle gatherings; i.e; (I) perfect metal removing oils (ii) water-dissolvable liquids & (iii) gasses. The water-solvent liquids can be delegated dissolvable oils (in water), concoction (manufactured) liquids or compound (semi-engineered) liquids. Liquids inside these sessions are accessible for light, medium and overwhelming obligation working. As a rule, biodegradable oils are exceedingly appealing replacements for oils since they are eco-accommodating, sustainable, less harmful and effortlessly biodegradable. Subsequently, vegetable-based oils are more plausible possibility for usage in industry as greases/MWFs.

Many research are in advance to grow new bio-based cutting liquids from different biodegradable oils. Due to ecological feelings of trepidation and developing directions over contamination, the expansion in requirement for sustainable and biodegradable oils is profoundly anticipated. A twelve-month to month development rate of approx. 9% for earth positive greases is normal in the US showcase throughout the following couple of years contrasted with a rate of 2% for the general oil advertise.

Vegetable oils are a handy and sustainable wellspring of eco benevolent oils. The larger part of vegetable oils comprise fundamentally of triacyl glycerides, which have atomic structure with three long chain unsaturated fats connected at the hydroxyl bunches by means of ester bonds. The unsaturated fats in vegetable oil triglycerides are all of comparable length, between 14and22 C (carbon) in length, with shifting levels of unsaturation.

The triglyceride arrangement of vegetable oils conveys capacities needed in an oil. Long, polar unsaturated fat chains gives high quality oil films that system firmly with metallic appearances, diminishing both erosion and wear. The solid inter-molecular connections are so hard to changes in temperature giving more steady thickness, or high consistency coefficient. The resemblance in all vegetable oil structures implies that lone a limited scope of viscosities are existing for their possible utilization as ointments. The solid inter-molecular connections while giving a solid oil film additionally end result in poor low temperature properties of oils.

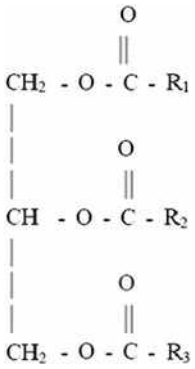

FIG 1: Typical vegetable oil's chemical structure.

The liquid likewise held on recyclable with low lethality at all phases of its life. Ointment manifestations are being produced in light of the benefits and points of confinement of vegetable oils. Denied of added substances, vegetable oils out-performed mineral base-oils in antiwear and grating, erosion stack limit and weariness protection. Completely defined vegetable oil oils, in contrast with mineral oil partners, show a lower coefficient of rubbing, comparing scraping load limit and better setting protection, yet additionally sub-par warm and oxidative dependability. At extraordinary burdens, vegetable oil-based ointments turn out to be altogether less powerful. Vegetable oils are especially powerful as limit greases as the high extremity of the whole base oil permits solid associations with the greased up surfaces. De Chiffre & Belluco assessed the execution of a scope of mineral and vegetable oil-based cutting liquids in an extensive variety of machining processes and found that vegetable based oil definitions showed equivalent or preferred execution over the reference business of mineral oil in all processes. In outline, vegetable oils do show many needed qualities, which make them extremely shrewd oils for some commonsense applications. The real institution issues, for example, low temperature properties and low protection from oxidative corruption are tended to by different techniques, for example, (I) reformulation of added substances, (ii) synthetic adjustment of vegetable based oils and (iii) hereditary change of the oil. In this study, vegetable oil based Metal Working fluids (MWFs) is applied in machining of Al7075 alloy have been done in detail and its applications as an substitute to mineral based oil are emphasized with its effect on tool wear and surface roughness of the material.

2. SCOPE OF THE STUDY:

Many aerospace and defense based components are made from these super alloys which can perform in vigorous conditions for bearing high temperatures and forces.

Also the ongoing demand of these metals in automobiles for safety purposes is increasing because of its low weight and high impact resistance properties.

3. OBEJECTIVES OF THE STUDY:

The main objective of this study is to minimize the tool wear and increase the surface finish of the Al7075 alloy with eco-friendly and cheap cutting fluids (coconut oil with suspended boric acid powder).

4. LITERATURE REVIEW:

M.A. Mahadi et al., (2017) studied the surface finish of AISI 431 steel in turning and using boric acid powder and vegetable oil as coolant and found that, the average surface roughness ranged from 0.979- 2.479 microns and had an improvement of around 7.21%. Also another noted result was found that to obtain high surface finish the feed rate should be as low as possible.

R. Teimouri et al.,(2017) studied the outcome of ultrasonic vibrations on the turning of Al7075 alloy and found that the vibrations reduced the cutting forces and enhanced the surface finish of the workpiece. Also the chip breakage changed due to vibrations which resulted in reduction of cutting forces and development in surface roughness.

N. Talib. et al., (2017) used crude jathropa oil (CJO) as base oil with some lubricant nano-particles of hexagonal Boron Nitride for machining. These results were compared with the results obtained from synthetic ester. Two tests were performed, tapping torque and four ball test. Different concentrations of nanoparticles were used and it was found that 0.05 wt.% improved the wear and friction of tool. Also it was found that concentration higher than 0.05 wt.% increased wear of tool due to particle aggregation.

L. Benkai et al., (2017) studied the performance of various nanoparticles like molybdenum disulphide (MoS2), Zirconium Dioxide (ZrO2), Carbo Nanotubes (CNT), polycrystalline Diamond (PCD), Aluminium Oxide(Al2O3) and Silicon Dioxide (SiO2) suspended in Palm oil which was used as base oil and their respective heat transfer performances were studied. It revealed that the carbon nanotube nano fluid has the maximum heat transfer coefficient (1.3 × 104 W/(m×K)). Overall it was found that CNT have the best heat transfer amongst the premeditated nano particles.

T. Bakalova et al., (2016) showed that the use of nanoparticle decreased the average and variance of friction coefficient by 8.9% and 20.4% respectively. TiO2, SiO2 and Ag nanoparticles were used in tribological study with Silver nitrate (AgNO3) and ascorbic acid (C6H8O6) as base fluid. Also antimicrobial and antioxidant activity were studied and was found that it reduced bacterial respiratory rate upto 90.4%.

A.K. Rasheed et al.,(2016) reviewed graphene based nanofluids and nanolubricants and made a conclusion that grapheme has an ability to enhance the viscosity, electrical conductivity, thermal conductivity and tribological properties of grease and base oils.

R. Kumar et al.,(2015) studied the surface finish in turning of AL7075 alloy by using RSM and Artificial Neural Networking (ANN) and using graphite as coolant which resulted in better surface finish of the material.

A.K. Sharma et al.,(2015) used TiO2 nanoparticles in vegetable oil-water emulsion in different concentrations, and thermal and tribological properties were enhanced. This results were obtained on AISI 1040 steel using MQL technique. This experimental results were compared with dry, wet and conventional mist techniques. It was found that upto 58.1% tool wear was reduced by using MQL and the cutting forces were reduced upto 62.67%. Also surface finish improved by 47.8%.

H. Xie et al.,(2015) used MoS2 and SiO2 nano particles with EOT5# engine oil in different proportions and found that lubrication was increased by considerable amount. The load carrying capacity of the base lubricant was improved by adding these particles and SiO2 reduced the friction coefficient.

M. Gulzar et al., (2015) inspected the Antiwear(AW) and Extreme pressure(EP) ability of modified palm oil with added nanoparticles of CuO and MoS2 and oleic acid as surfactant. It was found that incorporation of nanoparticles enhanced AW & EP properties by1.5 times. Oleic acid used reduced the wear of tool by considerable amount.

R. Padmini et al., (2015) used MoS2 as nanoparticle and dispersed it in coconut oil, sesame oil and canola oil. The cutting forces, temperature, tool wear and surface roughness decreased by 37%, 44%, 21% and 39% respectively and these results were obtained best in 0.5% Coconut oil+ nMoS2. Also the flash & fire point of oils were increased with the addition of nano-particles in it.

K. Venkatesan et al,(2014) studied tool wear and surface roughness while machining of Al7075 alloy with a coated carbide insert and found that there was an notable reduction in flank wear of insert abd the surface roughness of workpiece was also improved. The flank wear obtained was 76.94 microns.

S. Rawangwong et al,(2014) measured the influence of cutting paramters in face milling Al 7075 with carbide tool on tool wearout and surface finish. Through this experiment it was found out that wear mainly occurred due to speed and feed rate. The surface finish was mainly affected by cutting speed and feed rate. A formula was also developed for specific range of speed and feed and showed an mean percentage error of about 3.62%.

P. Escalona et al,(2014) developed models for surface roughness prediction and the results were 98% accurate when compared with experimental results. They used two types of square inserts for these experiment with different nose radius of 0.8 mm and 2.5mm respectively.

Y. Zhang et al., (2014) compared the results obtained by dispersing MoS2 particles in Soya bean oil, Palm oil and Rapeseed oil in comparison with liquid paraffin. It was found that as viscosity of base oil changes the thermal transfer rate decreases with the increase of viscosity but significantly increased lubricating property. Additionally it was watched that vegetable oils contain copious unsaturated securities and Carbon-carbon twofold securities, which are effectively oxidized by oxygen in air and prompt vegetable oil debasement. Along these lines, cancer prevention agents, for example, vitamin E ought to be added amid the test procedure to keep up oil strength.

K.P. Vamsi et al., (2013) studied the effect of nanoparticles during machining process by using vegetable oil as base fluid and MoS2 nanoparticles with boric acid. It was found that thermal properties like fire point, flash point, heat transfer coefficient and thermal conductivity were increased. Also there was reduction in tool flank wear and cutting forces.

S.A. Lawal et al., (2011) discussed the advantages of vegetable oil over commercially used cutting fluids. There was an performance enhancement in cutting force reduction, surface roughness of work piece, tool wearout and heat transfer rate at the metal removal zone. Coconut oil and Sunflower oil was used as cutting fluid for the machining of AISI 304 austenitic Stainless Steel. The thrust force was reduced with the reduction in tool wear.

K.P.Vamsi, et al., (2010) compared the performance of Nano boric acid suspended in SAE-40 and Coconut oil during machining of AISI 1040 steel. Change in tool temperatures, tool flank wearout and the surface finish of the machined surface with cutting rate and sustain were examined with Nanoboric acid suspensions in greasing up oil. Warm conductivity expanded and particular heat diminished with rate increment in Nano boric acid in base oil. Warmth exchange coefficient expanded marginally with increment in level of Nano boric corrosive in base oil and cutting rate.

J.N. Coupland et al., (1997) studied the physical properties of Eatable Oils. Properties like density, adiabatic expansion coefficient, viscosity, thermal conductivity(K), , ultrasonic velocity specific heat (constant pressure) and ultrasonic attenuation coefficient were arranged for a scope of lubricating oils and water at 20°C, and a progression of experimental conditions are recommended to ascertain the temperature reliance of these parameters.

5. EQUIPMENT AND MATERIALS:

Equipments:

- Lathe machine for Experimentation purpose.
- Tool makers microscope.
- Surface Roughness tester.
- Coolant sprayer.

Materials:

Aluminium 7075 alloy as workpiece material.

Coconut oil as base oil with suspended boric acid powder.

Coated Carbide inserts.

6. RESEARCH METHODOLOGY:

1) The experiment will be conducted on Lathe machine and the turning will be done on automatic feed with the fixed depth of cut.
2) There will be a total of 7 experiments conducted with different type of lubricating systems and same feed and depth of cut.
3) The toolwear and surface roughness will be measured every 10 min till 6 readings for each type of coolant.
4) Then an average of surface roughness for these 6 readings would be taken and compared with other values to find the optimum value.

DIFFERENT TYPES OF LUBRICATIONG SYSTEMS						
DRY	WATER	OIL	EMULSION	EMULSION +BORIC ACID POWDER	OIL + BORIC ACID POWDER	WATER+ BORIC ACID POWDER

7. PROPOSED WORKPLAN:

The materials have been ordered right now and will arrive by mid-December.

The experimental work will be started from first week of January and will end with results in two weeks.

8. EXPECTED OUTCOME:

From this study it is expected that the tool wear and cutting forces decreases to a considerable amount with a significance increase in heat transfer rate and surface finish of the workpiece.

9. SUMMARY AND CONCLUSIONS:

It can be seen that there is a decrease in tool wear by the use of fluids with added nanoparticles. Also the surface finish of the different materials used in these papers were increased with the reduction in cutting forces, decreased environmental effects and suitable for operator/s.

10. REFERENCES:

M.A. Mahadi, I.A. Choudhury, M. Azuddin, Y. Nukman, Use of Boric Acid Powder Aided Vegetable Oil Lubricant in Turning AISI 431 Steel, Procedia Engineering 184 (2017) 128 – 136

Reza Teimouri, Saeid Amini∗, Nasrodin Mohagheghian, Experimental study and empirical analysis on effect of ultrasonic vibration during rotary turning of aluminum 7075 aerospace alloy, Journal of Manufacturing Processes 26 (2017) 1–12

Talib N, Nasir RM, Rahim EA, Tribological behaviour of modified jatropha oil by mixing hexagonal boron nitride nanoparticles as a bio-based lubricant for machining processes, *Journal of Cleaner Production* (2017), doi: 10.1016/j.jclepro.2017.01.086.

Li B, Li C, Zhang Y, Wang Y, Jia D, Yang M, Zhang N, Wu Q, Han Z, Sun K, Heat transfer performance of MQL grinding with different nanofluids for Ni-based alloys using vegetable oil, *Journal of Cleaner Production* (2017), doi:10.1016/j.jclepro.2017.03.213.

Bakalova T, Svobodová L, Rosická P, Borůvková K, Voleský L, Louda P, The application potential of SiO2, TiO2 or Ag nanoparticles as fillers in machining process fluids, *Journal of Cleaner Production* (2016), doi:10.1016/j.jclepro.2016.11.054.

A.K.Rasheed , M.Khalid , W.Rashmi , T.C.S.M.Gupta , A.Chan,Graphene based nano fluids and nanolubricants – Review of recent developments, *Journal of Renewable and Sustainable Energy*,http://dx.doi.org/10.1016/j.rser.2016.04.072

A. Sharma, A. Tiwari, R. Singha, A. Dixit ,Tribological Investigation of TiO2 Nanoparticle based Cutting Fluid in Machining under Minimum Quantity Lubrication (MQL),Recent Advances In Nano Science And Technology 2015 (RAINSAT2015),Proceedings 3 (2016) 2155–2162

R. Kumar, S. Chauhan, Study on surface roughness measurement for turning of Al 7075/10/SiCp and Al 7075 Hybrid Composites by using surface methodology response

(RSM) and artificial neural networking (ANN), Measurement (2015), doi: http://dx.doi.org/10.1016/j.measurement.2015.01.003

Hongmei Xie, Bin Jiang, Junjie He, Xiangsheng Xia, Fusheng Pan, Lubrication performance of MoS2 and SiO2 nanoparticles as lubricant additives in magnesium alloy-steel contacts, Tribology International, http://dx.doi.org/10.1016/j.triboint.2015.08.009

M. Gulzar , H.H. Masjuki , M.Varman , M.A.Kalam , R.A.Mufti , N.W.M. Zulkifli, R. Yunus , Rehan Zahid, Improving the AW/EP ability of chemically modified palm oil by adding CuO and MoS2 nanoparticles,Tribology International 88 (2015)271–279

R. Padmini, P. Vamsi Krishna and G. Krishna Mohana Rao, Effectiveness of vegetable oil based nanofluids as potential cutting fluids in turning AISI 1040 steel, Tribiology International, http://dx.doi.org/10.1016/j.triboint.2015.10.006

K.Venkatesa, R.Ramanujam, Vignesh.V.Shanbhag, Nitin.N. Yalamoori , D.Venkata Subba Reddy, Preparation, Characterization and Machinability of Al7075-Al_2O_3 Matrix Composite Using Multi Layer Coated Carbide Insert **,** Procedia Materials Science Volume 5, 2014, Pages 1819–1828

Surasit Rawangwong, Jaknarin Chatthong, Worapong Boonchouytan, Romadorn Burapa, Influence of Cutting Parameters in Face Milling Semi-Solid AA 7075 Using Carbide Tool Affected the Surface Roughness and Tool Wear, Energy Procedia 56 (2014) 448 – 457

Patricia Mu˜noz-Escalonaa,, Paul G. Maropoulos, A geometrical model for surface roughness prediction when facemilling Al 7075-T7351 with square insert tools, Journal of Manufacturing Systems (2014)

Yanbin Zhang, Changhe Li, Dongzhou Jia, Dongkun Zhang, Xiaowei Zhang, Experimental evaluation of MoS2 nanoparticles in jet MQL grinding with different types of vegetable oil as base oil, Journal of Cleaner Production xxx (2014) 1-11

P Vamsi Krishna, R R Srikant, R Padmini, JLPP Viswaditya, Application of Nanomaterials as Coolants/ Lubricants in Machining, IEEE, doi:978-1-4799-1379-4/13/$31.00©2013

S.A. Lawal, I.A.Choudhury , Y.Nukman, Application of vegetable oil-based metal working fluids in machining ferrous metals—A review, International Journal of Machine Tools & Manufacture doi:10.1016/j.ijmachtools.2011.09.003

P. VamsiKrishna , R.R.Srikant , D.NageswaraRao, Experimental investigation on the performance of nano boric acid suspensions in SAE-40 and coconut oil during turning of AISI 1040 steel, International Journal of Machine Tools & Manufacture 50(2010)911–916, doi:10.1016/j.ijmachtools.2010.06.001

C.P. Tan, Y.B. Che Man, Differential Scanning Calorimetric Analysis of Edible Oils: Comparison of Thermal Properties and Chemical Composition, Paper no. J9207 in JAOCS 77, 143–155 (February 2000).

John N. Coupland, D. Julian McClements, Physical Properties of Liquid Edible Oils, JAOCS 74, 1559–1564 (1997).