

Analysing the Effect of Coconut Oil Based Cutting Fluid for Turning Operation of EN19 Steel on CNC Lathe

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Abstract— The cutting fluids are responsible for reducing heat at tool work interface, reducing the cutting force, easy chip removal, high material removal rate (MRR), lubrication improvement between tool and work piece and thereby increasing the surface finish. Good lubricating capacity, less viscosity, better heat removal rate, high heat conductivity and specific heat are the desired flow and heat transfer parameters of cutting fluids. The development of lubricants like cutting fluids traditionally has mineral oil as base fluid. This fact is related to the technical properties and the reasonable price of mineral oils. Issues of using fluids in machining related to health, environment, and manufacturing cost that need to be solved and options to reduce their use has to be developed. Hence there arises the need for an ecologically benign metal working fluid in machining operations. In this work a coconut oil based cutting fluid is developed with different concentration of oil and water. Different properties of these fluids are also found out. A comparative study of using Coconut oil based fluids and Mineral oil based fluid were conducted by taking stainless steel as workpiece material on a conventional lathe.

Key words: Cutting fluids, CNC Turning Centre, Coconut Oil Based Fluid

I. INTRODUCTION

The machining processes have an important place in the traditional production industry. Cutting fluids have been used widespread in all machining processes. The positive effect of the use of fluids in metal cutting was first reported in 1894 by F. Taylor, who noticed that by applying large amounts of water in the cutting area, the cutting speed could be increased up to 33% without reducing tool life. Since then, cutting fluids have been developed resulting in an extensive range of products covering most work-piece materials and operations.

The conventional cutting fluids are the mineral oils in two groups straight oils or water based fluids. The major concerns about the cutting fluids are functional, economic and ecological dimensions. Based on these there are several unsustainable issues. Almost all straight oils are extracted from the crude oil which is decreasing rapidly and in turn increases the price of crude oil and decrease in its availability. The use, disposal etc. of conventional cutting fluid will adversely affect the nature very badly. Human health will be negatively affected by direct contact of cutting fluid with skin, which lead to occupational disease and also its contact with eyes will cause damage to the eyes. During machining certain fumes are produced at the contact point, The inhalation of this fume produced causes respiratory diseases. The disposal of this cutting fluid causes air, water and soil pollution. In order to avoid or minimize the use of cutting fluids, several methods were introduced, but make the production costlier. Thus there arise the need of a good

alternative cutting fluid which is having the desired properties of the ordinary cutting fluid and which will not produce an environmental impact. In this paper the study of a coconut oil based cutting fluid. A comparative study of Coconut oil based fluids and Mineral oil based fluid were conducted by taking EN-19 steel as workpiece material on a CNC Turning Centre.

II. LITERATURE REVIEW

1) V.D.Prabhu and Praveen D. Dethan (2016) "Experimental Evaluation of Natural Cutting Fluid in Turning" calculated the surface roughness of the mild steel (AISI 1040) work piece in turning under different eco-friendly cutting fluids as a coolant. The single point cutting tool is used for machining cylindrical shape specimen of mild steel. The soya bean oil, coconut oil, canola oil, rice bran and normal coolant (servo-cut oil) are the cutting fluids used in this operation and also the machining process is done in dry condition. A number of tests are performed with different cutting speeds, different cutting fluids and with varying depth of cuts. Surface Roughness values are obtained from these experiments and these are used for data analyzing the cutting process. The High speed steel tool was used for the experimental work. The experiments are carried out to find the variation of Surface Roughness with respect to the cutting speeds and cutting fluids and the best cutting fluid under various cutting speeds and depth was found out.

It is concluded from the results found out in the previous sections, at 500 rpm coconut oil is having higher surface finish, and also at 325 rpm canola oil is found to be effective. Since eco-friendly fluids are used, the operator had not found any difficulty while doing machining operation and also while disposing the cutting fluids. It is found that eco-friendly cutting fluids are having more surface finish than the conventional cutting fluids. The reusability of cutting fluids has been increased and hence reduction in the cost of cutting fluid. The best surface finish is obtained from the Canola oil with an average surface finish value of 3.031 μ m at the cutting speed of 325 rpm and 38 mm/min and at 500 rpm coconut oil is found to be effective with average roughness of 3.127 μ m at 38 mm/min. The surface roughness value of the vegetable oils is less than the normal coolant used. Hence it can be concluded that, the vegetable based coolant derivatives possess good properties and stands next to the coolants derived from petroleum products .

2) K.P.Sodavadia and A.H.Makwana (2014) "Experimental Investigation on the Performance of Coconut oil Based Nano Fluid as Lubricants during Turning of AISI 304 Austenitic Stain- less Steel" presented the performance of nano cutting fluid in

machining, one of the most fundamental process in manufacturing industries. The heat generated at the tool-chip interface during machining is critical for work piece quality. The cutting fluids which are widely used to carry away the heat generated at the tool-workpiece interface in machining process that do not possess a pathogenic clinical history and are relatively free from inherent hazards. Hence there arises a need to develop an eco-friendly and user friendly nano cutting fluid over conventional cutting fluids. Coconut oil has been used as one of the cutting fluids in the work because of its thermal and oxidative stability which is higher than that of other vegetable based cutting fluids used in machining industries. The present work investigates the application of nano Boric acid, solid lubricants suspension in coconut oil during turning of AISI 304 austenitic stainless steel with carbide tool. Where in nano boric acid solid lubricants of 50 nm particle size were suspended in coconut oil, base lubricant. So the variation of average tool flank wear, surface roughness of the machined surface and cutting tool temperature with cutting speed and feed are identify with nano solid lubricant suspensions in coconut oil.

The Nano fluid lubricants were prepared by suspensions of Nano Boric acid in coconut oil so thermal conductivity and heat transfer coefficient increased and specific heat decreased with percentage increase in Nano boric acid. So cutting temperatures, tool flank wear and surface roughness were decreased significantly with Nano lubricants compared to base oil, due to the better lubricating properties of it. In all the cases, coconut oil with 0.5% Nano Boric acid suspensions showed better performance compared to other Nano fluid in terms of cutting temperatures, tool flank wear and surface roughness.

3) Sunday Albert Lawal, Intiaz Ahmed Choudhury & Yussof Nukman (2013) "Evaluation of vegetable and mineral oil-in-water emulsion cutting fluids in turning AISI 4340 steel with coated carbide tools" The selection of cutting fluid additives for the formulation of oil-in-water emulsion using palm kernel and cottonseed oils are not dangerous or problematic to the environment or harmful to workers. Design of experiment using full factorial method was employed in the process of cutting fluid formulation, while the effect of formulated cutting fluids on surface roughness and cutting force in turning AISI 4340 steel with coated carbide using Taguchi method were investigated and compared with conventional (mineral) oil-in-water emulsion cutting fluid. Four factors and three levels experimental design (L27) was adopted in the Taguchi method. Minitab -14 statistical analysis software which is widely used in engineering application was used in the analysis of S/N (dB) ratio and ANOVA. Cutting speed, feed rate, depth of cut and types of cutting fluids were considered as input parameters. ANOVA results show that cutting speed (64.64%) and feed rate (32.19%) have significant influence on the surface roughness and depth of cut (33.1%) and type of cutting fluids (51.1%) have significant influence on the cutting force.

The main contribution of this study is that novel vegetable oil in water emulsion cutting fluids formulations have been developed, which could be used to improve the surface roughness and cutting force during turning of AISI 4340 steel with coated carbide tools. The pH values for PKO (10.46) and CSO (10.98) cutting fluids are within the acceptable level required to avoid corrosion during machining process and does not pose any health hazard to worker.

4) Sunday Albert Lawal (2013) "A Review of Application of Vegetable Oil-Based Cutting Fluids in Machining Non-Ferrous Metals" cutting fluids consisted of simple oils applied with brushes to cool and lubricate the machine tool. However, cutting fluid formulation became more complex as cutting operations became more severe. There are several types of cutting fluids nowadays and the most common can be categorised into cutting oils or water-miscible fluids. In this paper, attention is focused on recent research work on the application of vegetable oil-based cutting fluids in machining non-ferrous metals. The efficiency of various vegetable oil-based cutting fluids based on some process parameters such as thrust force, temperature developed at the tool chip interface and flank wear during machining of some non-ferrous metals using different tool materials were highlighted. The results obtained established vegetable oil-based cutting fluids as a good metalworking fluid.

When groundnut, coconut, palm kernel and shear butter oils were used as cutting fluids during the cylindrical turning of copper and aluminium using tungsten carbide tool material. The lowest reduction of cutting forces of 100, 130 and 200N were recorded for groundnut oil when aluminium was machined at cutting speed of 8.25 m/min, depth of cut of 2 mm and feed rates of 0.10, 0.15 and 0.20 mm/rev respectively. While the highest cutting forces of 210, 250 and 380 N were recorded for coconut oil respectively under the same machining conditions. The best cutting force of 220 N was reported for copper when palm kernel oil was used as cutting fluid under the same machining conditions .

5) S.A.Lawal, I.A.Choudhury, Y.Nukman (2011) "Application of vegetable oil-based metal working fluids in machining ferrous metals—A review" The increasing attention to the environmental and health impacts of industrial activities by governmental regulations and by the growing awareness level in the society is forcing industrialists to reduce the use of mineral oil-based metalworking fluids as cutting fluid. Cutting fluids have been used extensively in metal cutting operations for the last 200 years. In the beginning, cutting fluids consisted of simple oils applied with brushes to lubricate and cool the machine tool. As cutting operations became more severe, cutting fluid formulations became more complex. There are now several types of cutting fluids in the market and the most common types can be broadly categorised as cutting oils or water-miscible fluids. In this review, the applicability of vegetable oil-based metalworking fluids in machining of ferrous metals has been undertaken. The advantages of metalworking fluids and its performances with respect to the cutting force,

surface finish of work piece, tool wear and temperature at the cutting zone have been investigated. It has been reported that metal working fluids, which are vegetable oil-based, could be an environmentally friendly mode of machining with similar performance obtained using mineral oil-based metalworking fluids.

- 6) Y.M.Shashidhara, S.R.Jayaram (2010) "Vegetable oils as a potential cutting fluid—An evolution" study highlights the contributions from more than sixty authors on vegetable based oils as emerging environmental friendly cutting fluids. The performance of these oils as emulsions and straight oils for various materials and machining conditions are reported. The study focuses on the evolution of vegetable oils as cutting fluids in manufacturing sector, particularly, metal cutting and metal forming. It is observed that, most of the contributions are directed to develop and commercialise the cutting fluids based on vegetable oils.

Vegetable oils were found to be promising alternative for mineral based oils due to their environmental friendly characteristics. These were utilized to develop biodegradable lubricants for various industrial applications. The trend was extended to formulate environmental friendly metal working fluids. The review is made in two approaches, one based on the desirable properties of vegetable oil as metal working fluid and other on the performance of these oils for various cutting and forming operations. Finally, the review revealed that the vegetable oils have large scope to utilize them as metal working fluids.

- 7) Patrick Adebisi Olusegun Adegbuyi, Ganiyu Lawal, Oluwatoyin Oluseye, Ganiyu Odunaiya(2010) "Analysing the effect of cutting fluids on the mechanical properties of mild steel in a turning operation" Cutting fluids are used in machining for a variety of reasons such as improving tool life, reducing work-piece thermal deformation, improving surface finish. In this work soluble oil, water and palm kernel oil were used as coolants in turning operations. Tungsten carbide and HSS cutting tools were employed as cutter with cutting speed of 355rpm. Turning was done under dry condition and also using 3 coolants. Temperature and Hardness values after each cut were recorded. The microstructure of all the specimen was also done and recorded. It was revealed that variation in the Hardness value of the samples with progress in machining time is more with the use of carbide tool compared to the HSS cutter. Samples cooled with water exhibited the highest hardness value.
- 8) Salete Martins Alves, Joao Fernando Gomes de Oliveira "Development of new cutting fluid for grinding process adjusting mechanical performance and environmental impact" new combinations of fluids and grinding wheels have been tested in research projects. The application of grinding wheels using cubic boron nitride (CBN) abrasives is a strong tendency in grinding. An environmentally friendly fluid has to accomplish some main requirements, such as should not be toxic, biodegradable and should produce low emissions when in use. But also an ideal fluid has to provide good process performance and allow low costs in the

application of CBN based tools. This work presents a new grinding fluid formulation able to meet both the performance and environmental requirements. The proposed fluid is based on a sulfonate vegetable oil with high concentration in water for grinding with CBN in high speed. This way it is possible to get high lubricity and good performance on CBN grinding. The tests show that the application of the proposed formula in CBN grinding results in process performance equivalent to the obtained using mineral neat oils. The parameters evaluated were radial wheel wear and workpiece roughness. Chemical analysis shows the new fluid as to be non-toxic and have easy biodegradability. The cutting fluid developed in this work has filled all environmental requirements as well as has a good grinding performance.

- 9) Ajay Vardhaman B. S , M. Amarnath, Durwesh Jhodkar, J. Ramkumar and H. Chelladurai "Examining the Role of Cutting Fluids in Machining AISI 1040 Steel Using Tungsten Carbide Insert under Minimal Quantity Lubrication Condition " all machining operations, tool wear is a natural phenomenon. Excessive wear on cutting tools alter the dimensions of manufactured components, which result increase in scrap levels thereby incurring additional costs. Though cutting fluids are widely employed to carry away the heat generated at the tool-work piece interface, their applications have several adverse effects on ecology and the health of workers. Attempts have already been initiated to control the pollution problem using minimal quantity lubrication (MQL) method which also leads to economical benefits and work piece/tool/machine cleaning cycle time. In the present work, experimental investigations were carried out to investigate the role of MQL by vegetable oil on cutting forces and tool wear in turning AISI 1040 steel using tungsten carbide cutting tool insert. The results revealed that, the performance of MQL by coconut oil found to be superior to that of dry turning, conventional wet turning and MQL by soluble oil on the basis of cutting force and tool life.
- 10) Sanusi Olawale Monsur, Bello Yekini and Akindapo Jacob Olaitan "Evaluating the performance of different type of cutting fluid in the machining of aluminium-manganese alloy in turning operation" The research aimed to evaluate the performance of neem seed oil as a cutting fluid in orthogonal machining of aluminium-manganese alloy 3003, carbide cutting tool insert was used as a cutting tool under different machining parameters of spindle speed, feed rate and depth of cut with different types of cutting fluids (neem seed oil and soluble oil) as well as dry machining. The results were obtained in terms of the average surface roughness of the machined workpiece and flank wear under different cutting parameters (spindle speed, feed rate and depth of cut). The results indicated that the neem seed oil cutting fluid reduced the surface roughness by 39% and 22% as compared to dry turning and soluble oil cutting respectively. It was established from the results that the neem seed oil cutting fluid reduced the flank wear by 72% and 56% as compared to dry turning and soluble oil cutting respectively. Based on the study, it can be

concluded that neem seed oil cutting fluid facilitates a better surface finish and substantial reduction in tool wear when compared with dry and soluble oil machining.

- 11) Prasanna P Kulkarni, Shreelakshmi.C.T., Shruti.V.Harihar, Radha Bai.N. "An Experimental Investigation of Effect of Cutting Fluids on Chip Formation and Cycle Time in Turning of EN-24 and EN-31 Material" The chip formation is not only depending upon the work piece material but even on the cutting fluids and grain structure of the materials. Cutting fluids have seen extensive use and have commonly been viewed as a required addition to high productivity and high quality machining operations. This experiment is to determining the effect of cutting fluids and cutting parameters on chip formation mode and cycle time in turning of EN-24 and EN-31 material. The above operation has been carried out in dry cutting condition, Flood application of cutting fluids. Cutting fluids like soluble oil and palm oil used in the present work. The cutting operations were carried out on a conventional lathe machine there by making turning operation with uncoated carbide cutting tool at different spindle speed(n) of 210rpm, 450rpm and 750rpm. Also feed(f) of 0.1rev/min to 0.2rev/min. Depth of cut is kept constant at 1.5mm. By using the vegetable oil we can improve the surface finish, metal removal rate and to reduce the environmental effects. After conducting these experiments it was recorded chip morphology and cycle time value for each fluid under different cutting conditions. It was observed light colour chips with segmented form in vegetable based oil at lower cutting conditions for each material.
- 12) Ujjwal Kumar, Atif Jamal, Aftab A. Ahmed "Performance Evaluation of Neat Vegetable Oils as Cutting Fluid during CNC Turning of Aluminium (AA1050)" Comfortable and healthy workplaces are important for sustainable machining. Sustainable machining should be reliable and consistent. Green machining means environment friendly and hazard free, this is some- how achieved by the machining with Vegetable oil Based Cutting Fluids (VBCFs). Unfortunately, Metal Working Fluids also have several negative health and environmental impacts. Vegetable oils have become identified world over as a potential source of environmentally favourable metal working fluids due to a combination of biodegradability, renewability and excellent lubrication performance. This paper focuses on an experimental investigation into the role of green machining on surface Roughness (Ra), in the machining of aluminium AA1050. A comparative study of turning experiments, between VBCFs and MBCFs under various cutting conditions, using neat or straight Coconut oil and Castor oil, was conducted using the same machining parameter set-up. Vegetable oils used on the principle of Minimum Quantity Lubrication (MQL) that is oil dropped between the cutting tool and workpiece interface directly. The results show that vegetable oil performance is comparable to that of mineral oil

machining. The results show that Vegetable oils have potential to replace the Mineral oils.

III. CONCLUSION

Most of the researchers have used neat vegetable oils as cutting fluid but needs to add some additives for make better cutting fluid.

Results shows that some properties which is required for better cutting fluid is almost same in vegetable oil & generally used oil.

Coconut oil has a long shelf life compared to other oils, lasting up to two years due to its resilience to high temperature. Coconut oil is best stored in solid form at temperature lower than 24.5°C (76°F) in order to extend shelf life. However, unlike most oils, coconut oil will not be damaged by warmer temperatures and coco cutting fluid can be a good substitute cutting fluid in turning.

There is very less work in EN19 workpiece material using natural cutting fluid.

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