International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Volume 1 Issue 11 (November 2014) www.ijirae.com

A Review on Study of Performance of Vegetable based oils as Cutting Fluid in Machining of Alloys

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Abstract—Cutting fluids of various types are usually employed to control the heat generated in machining. The continued application of conventional cutting fluids is being challenged by the need to reduce overall volume of fluids, minimize health risks and bio-confirmation. Functions such as improving tool life and machining process efficiency, enhancing surface integrity and part accuracy, reducing cutting forces and vibrations are obtained by using cutting fluids. Mineral, synthetic and semi-synthetic cutting fluids involve in the ecological cycle with air, soil and water and their toxicity effect damages the ecosystem. In the reviewed papers researchers suggested that to overcome problems in machining, vegetable based cutting fluids can be used to optimize machining conditions.

Keywords— Taguchi method, orthogonal array Cutting fluids, cutting force, tool life

I. INTRODUCTION

In recent decades, the negative impacts of conventional cutting fluids are becoming more and more prominent. Traditional cutting fluids are effective in cooling, lubrication and carrying away chips during machining operations such as drilling, turning and grinding. While machining, cutting fluids are sprayed out through nozzles to the workpiece and the quantity of cutting fluids is substantial. Many researchers are trying to solve problems with worker's health while machining through new discoveries and technologies. Recently, considering the large amount of waste liquids from manufacturing, manufacturers have applied dry machining as well as minimum quantity lubricant (MQL) strategies involving low-volume sprays of oil delivered in compressed air. The introduction of vegetable oil-based coolants in machining applications has made it possible to achieve quantum increases in overall performance. As a proven and tested technology, vegetable oils have been recognized as having superior lubricating properties since the 1960s. During this time, the process of stabilizing coolant emulsions that are based on water-miscible vegetable oils proved to be challenging, which meant that machining lubricant options were limited to mineral oil-based coolants containing various additives. Vegetable oil can be used for the most part in straight oil applications.

II. LITERATURE REVIEW

M. Venkata Ramana et al [1] discussed about specific study and application of bio-asserted cutting fluid such as palm oil on turning of titanium alloy (Ti-6Al-4V) and the application of solid lubricant mixture like boric acid in palm oil on turning of Ti-6Al-4V alloy is studied. The work involves experimental investigations of the performance of three cutting conditions such as dry, palm oil, mixture of palm oil and boric acid lubricant in terms of surface roughness. The Taguchi method is used to find out the optimal cutting parameters for surface roughness. The orthogonal array and signal to noise ratio are employed to study the performance characteristics. The results indicate that there is considerable improvement in the machining performance using palm oil and palm oil with boric acid compared with dry machining. The result also indicated that palm oil is higher in performance compared to dry and palm oil with boric acid mixture as cutting fluid in this work due to this thermal and oxidative stability which is being comparable to other vegetable cutting fluids used in machining.

M.M.A. Khan et al [2] presented 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. 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.

Babur Ozcelik et al [3] focused on both formulation of vegetable-based cutting fluids (VBCFs) and machining with these cutting fluids. For this purpose, characterizations of chemical and physical analyses of these formulated cutting fluids are carried out. In this study, performances of three VBCFs developed from crude sunflower oil, refined sunflower oil, refined canola oil and commercial semi-synthetic cutting fluid are compared in terms of tool wear, thrust force and surface roughness during drilling of AISI 304 austenitic stainless steel with HSSE tool. Experimental results show that canolabased cutting fluid gives the best performance due to its higher lubricant properties with respect to other cutting fluids at the constant cutting conditions (spindle speed of 750 rpm and feed rate of 0.1 mm/rev).

J. B. Shaikh et al [4] in this workthey have determined the influence of lubricant on surface roughness and material removal rate (MRR) by using CNC LATHE Machine with AISI D2 steel. Taguchi Method is used for determining and optimising operating parameters. The experimentation is proposed to identify the influence of cotton seed oil on AISI D2 steel. Further the usability of cotton seed oil will be checked in turning operation at low and high speeds. The performance of cotton seed oil is compared with servo cut oil and soybean oil. The above experimentation results may help practitioners to compare and increase MRR, Surface finish using more environment friendly oil as lubricant.

Sharafadeen Kunle Kolawole et al [5] evaluated the performances of palm oil and groundnut oil were compared with that of mineral oil-based cutting fluid during machining operation of mild steel. Temperature of the workpieces as well as their chip formation rates using these vegetable oils as cutting fluids under different cutting speed (rev/min), feed rate (mm/rev) and depth of cut (mm) were compared with that of mineral oil and dry machining. The average temperatures of the workpieces were obtained at different depths of cut; 5mm, 10mm and 15mm under different cutting conditions. The temperature of the workpiece when groundnut oil was used as the cutting fluid was very close to that of the conventional oil, which was the lowest. Palm oil gave the overall highest chip thickness of 0.27 mm probably due to its better lubricating property. This was followed by that of the groundnut oil and the conventional oil as compared with dry machining of 0.17 mm thickness. Vitamin-C- rich-lemon fruit extract was used as an antioxidant to improve the oxidative stability of the vegetable oils. Viscosities of the various fluids were also analysed, and lowest average viscosity value of 28.0 Poise was obtained using groundnut oil. This shows that groundnut oil possesses better fluidity and faster cooling capacity than other oil samples. Samples lubricated with mineral-oil based fluid show fine microstructures, similar to what obtained using groundnut oil based cutting fluid. Fine surface morphology indicates improved surface roughness compared to using other cutting fluids. Based on these results, groundnut oil and palm oil are being recommended as viable alternative lubricants to the mineral oil during machining of mild steel.

S. A. Adam et al [6] focused on the study of surface roughness and chip formation during milling operation of Mild Steel using vegetable based oil as a lubricant. Experimental set up designed by using milling machine. Taguchi Method of Orthogonal Array with factorial design of experiments used to analysis the response. Surface roughness and chip formation predicting models was developed by using experimental data and analysis of the present lubricant and vegetables based oil. In the development of predictive models, cutting parameters of cutting velocity, feed rate, and depth of cut were considered as model variables. Further, the Analysis of Variance (ANOVA) technique was used to analyze the influence of process parameters and their interaction during machining. From the analysis, it is observed that cutting speed is the most significant factor on the surface roughness followed by depth of cut and feed rate. While Sunflower Oil gives the lowest surface roughness by setting of the best combination parameter. Besides, the most influenced factor that contributes to larger chip formation is depth of cut. Even the lower cutting speed and smaller feed rate had been used, the size still become larger when it comes to the increasing of depth of cut.

Literature Outcome

From the literature review, it is observed that less research work has been seen for SS316L austenitic stainless steel in turning by the use of ‘castor oil’ as cutting fluid. Also very less work has been reported for optimization of various turning parameters on SS316L material.

III. EXPERIMENTAL DETAILS

Work piece, cutting tool, machine for turning, vegetable based cutting fluid, selection of cutting parameters and machining conditions can be selected for the experimentation. To record the input and output parameters suitable orthogonal array can be used. For the analysis and to study response variables regression methods, Signal to noise ration and Annova can be used. Following steps can be followed for experimentation

IV. RESEARCH METHODOLOGY

Step1. Selection of Taguchi method
Step 2. Selection of raw material
Step3. Selection of Machine
Step4. Selection of machining parameters and conditions, levels
Step5. Selection of cutting fluid
Step 6. Machining w. r. t. cutting parameters and measurement
Step7: Results and discussion
Step8. Analysis of results and conclusion

V. OBJECTIVES

1. To investigate the effect of different cutting parameters like depth of cut, feed rate, cutting speed on SS316L material.
2. To find out the optimum cutting condition.
3. To optimize cutting force, power consumption, surface roughness, MRR, Machining time.
4. To observe the chip thickness, its colour.
5. To observe the effect of insert nose radius.

VI. CONCLUSION AND FUTURE SCOPE

From the review it is concluded that various vegetable based cutting fluids can be used to optimise cutting parameters and to create healthy environment for machining operators. Also from the review of different journal papers it is observed that, research has not been done on 'castor oil' as vegetable based cutting fluid.

ACKNOWLEDGMENT

This paper bears impart of many people. It is joyful occasion for all of us to publish our paper. I would like to express my deep sense of gratitude to my guide Prof. V. V. Potdar and friends for giving valuable time, precious guidance which helped us in completion of paper successfully.

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