

A Review on recent Developments and Performance of Environment friendly Cutting Fluids in Machining of Alloys

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Abstract:

As cutting fluids have been a traditional choice in reducing temperatures at the tool/work piece interface and surface roughness of the finished product, it is essential that the fluid used caused no health hazard, environmental damage. This paper demonstrates a literature survey on the development of environment friendly cutting fluids and their effects on many essential factors in machining like interface temperatures, surface roughness and material removal rate.

Keywords—

Cutting fluid; Machining; Surface roughness; Cryogenics; tool wear

I. INTRODUCTION

Cutting fluids or oils are those fluids which are used in machining processes for the primary purpose of heat dissipation, lubrication and corrosion prevention. The revolution in cutting fluids came when mineral oils were discovered to have cooling properties. The different types of cutting fluids are straight oils, soluble oils or semi synthetic oils and synthetic oils. With increase of cutting speeds in machining, abrupt use of cutting fluids began. In order to curb the environmental damage and health hazards caused due to them the researchers across the world started working on new types of methods of application and new types of

cutting fluids in order to find out environment friendly alternatives keeping in mind increasing quality and decreasing tolerances for the finished products in machining industry.

II. LITERATURE REVIEW

M. Anthony Xavier et al. (2008) identified the influence of cutting fluids on tool wear and surface roughness during turning of AISI 304 with carbide tool. The performance of coconut oil was compared with other two cutting fluids namely an emulsion and neat cutting oil. The results indicated that coconut oil proved better than other two cutting fluids in reducing tool wear and improving surface finish.

M.M.A. Khan et al. (2009) presented the effects of minimum quantity lubrication (MQL) using vegetable oil based cutting fluid while turning a low alloy steel AISI 9310 using uncoated carbide tool, comparing it to completely dry and wet machining in which MQL proved superior due to its ability to reduce cutting zone temperatures, tool wear rate and Surface roughness for various speed and feed ranges keeping D.O.C constant at 1mm.

Liu Junyan et al. (2009) investigated the effect of water vapour as an environment friendly coolant and lubricant in cutting of ANSI 304 stainless steel and found out that there was a reduction of about 50- 75% in tool wear rate and decrease in cutting force

was found to be over 25-30% for K 20 cement carbide cutting tool.

Matthew Alberts et al. (2009) conducted a study using a mixture of IPA and graphite nanoplatelets as a coolant and lubricant. The focus of the study was to evaluate the performance of graphite nanoplatelets as a lubricant for surface grinding of hardened D-2 tool steel. It was deduced that the proper selection of graphite particle size, carrying medium and application method can lead to low cost, non toxic alternative to solid lubrication or MQL grinding.

P. Vamsi Krishna et al. (2010) aimed at a specific study of the application of nano solid lubricant suspensions in turning of AISI 1040 steel with carbide tool, keeping a constant D.O.C, flow rate and varying Cutting speed and feed rate. SAE 40 and coconut oil were used as base liquids with boric acid suspensions of 50 nm particle size. It was found that in terms of cutting temperatures, tool wear and surface roughness Coconut oil showed optimum and better results as compared to SAE 40 at 0.5% of nanobaric acid suspension.

Babur Ozcelik et al. (2011) performed experimental studies on environment friendly refined sunflower oil and canola oils including different percentage of extreme pressure (E.P) additive (polar tech XP 9018) and two commercial cutting fluids in turning AISI 304L steel comparing them with respect to surface roughness, tool wear, cutting and feed forces. The results indicated that 8% of E.P additives included in canola based cutting fluid performed better than the rest.

A. Shokrani et al. (2012) presented one of the very first studies on the effect of liquid nitrogen coolant in CNC end milling of Inconel 718 nickel based alloy using TiAlN coated solid carbide tools as compared with

dry CNC milling. The analysis revealed that cryogenic cooling resulted in 33% and 40% reduction in Ra and ISO Rz surface roughness respectively but despite improvement in surface roughness it significantly reduced tool life.

B. Dilip Jerold et al. (2012) investigated the influence of cryogenic coolants CO₂ and liquid nitrogen (LN₂) on a numerous parameters in machining of AISI 1040 steel compared to wet machining. It was found out that cryogenic coolants reduced cutting temperatures drastically improving surface finish and reducing tool wear. The use of cryogenic LN₂ reduced the cutting temperatures from 3- 17%. when compared to CO₂ coolant. Application of CO₂ coolant reduced cutting forces, improved surface finish from about 2-12% and also reduced tool wear rates when compared to LN₂ and wet machining conditions.

S. Khandekar et al. (2012) presented a comparative study on nano cutting fluid made by adding 1% Al₂O₃ nano particles to conventional cutting fluid. The study revealed that the cutting force, workpiece surface roughness and tool wear are reduced by using nano cutting fluid compared to dry machining and machining with conventional cutting fluid.

V. Dhokia et al.(2012) conducted an experimental investigation for end milling operation of 6061- T6 aluminum using liquid nitrogen and concluded that cryogenic cooling resulted in reduction of surface roughness (Ra) as compared to dry and wet machining.

MMS Prasad et al. (2013) conducted a study on the use of nano cutting fluid (nano graphite powder) in MQL for turning AISI 1040 steel in varying proportions of concentration and different flow rates. It was



found out that nano fluids in MQL gave better performance than dry machining.

Srinivasa Rao Nandam et al. (2014) performed an experimental investigation on machining of tungsten heavy alloys by solid carbide cutting tools under cryogenic and conventional coolants. The material removal rate (MRR), surface integrity and cutting forces were thoroughly studied. It was concluded that when compared to conventional cutting fluid, MRR increased by more than 3 times for cryogenic coolant and surface finish of machined were also found to be better.

III. CONCLUSION

The above literature suggests that cutting fluids are evolving rapidly as eco friendly fluids giving optimal results for different machining operations. The capability of a fluid depends on the type of machining process and work piece material for which the fluid is being used. Vegetable oils can serve as a green alternative to mineral based cutting oils and can further be improved by trying some additives for improving their thermal stability and anti corrosive properties for pragmatic industrial use and for operations which require high quality in terms of surface roughness, Costly cryogenic fluids can be used.

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