Machining using Minimal Quantity Lubrication- A Review

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***Abstract* —** *This paper attempts to show that the various research work of MQL using various types of cutting fluids. Fluid selection is vital for MQL because it must be a better-quality fluid such as vegetable oil or synthetic oil. The costs of these better-quality fluids are higher but eliminate the need for costly fluid recycling and disposal services. In recent times, MQL is extensively used in machining performances.*

Keywords — *MQL, Machining, Cutting Fluid*

I. INTRODUCTION

In Minimal Quantity Lubrication process, oil is mixed with high pressure air and the resulting spray is supplied near to the cutting edge. This spray impinges at high speed on the cutting zone through the nozzle. Air in the spray provides the cooling function and chip removal, whereas oil provides lubrication and cooling by droplet evaporation [8]. In MQL application, heat transfer is primarily in the evaporative mode, which is more competent than the convective heat transfer prevalent in conventional wet turning. MQL brings out better tool life, improving surface finish, low cutting force and better chip forms. Also it reduces machining floor space; eliminates coolant pump, coolant testing, coolant treatment and coolant disposal and allows the operator to observe the performance during machining [9].

II. LITERATURE REVIEW

N.R. Dhar et al (2007) [1] have determined mechanical performance of MQL to completely dry lubrication for the turning using AISI-1040 steel as a work material and Carbide, SNMM 120408 as a tool insert based on experimental measurement of cutting temperature, cutting forces, tool wears, surface finish, and dimensional deviation. The cutting performance of MQL machining is better than that of dry machining because MQL provides the benefits mainly by reducing the cutting temperature, which improves the chip–tool interaction.

Vishal K. et al (2015) [6] have experimented by using vegetable oil to know the effect of different machining parameters on tool tip temperature with EN8 as a work material using soya oil as a lubricant. In this work, cutting parameters are spindle speed, feed rate and depth of cut. Experiment are designed and conducted based on Taguchi's L9 Orthogonal array design. From the experiment it is found that spindle speed is the most significant factor on tool tip temperature followed by feed rate and depth of cut.

E. A. Rahim et al (2015) [3] have experimented that efficiency of MQL technique was compared to dry technique with respect to cutting temperature, cutting force, tool-chip contact length and chip thickness, using MQL based synthetic ester as the cutting fluid with 1045 steel as a work material and uncoated carbide as a tool insert. In this work, cutting parameters are cutting speed, feed rate and depth of cut. From the study it is found that, MQL machining technique was found to be more superior to dry condition. Also the use of synthetic ester as optimal lubricant for MQL machining has been proven to produce better cutting performance than using vegetable oil and mineral oil.

Upadhyay, V et al (2012) [8] have studied that MQL has resulted in better tool life, improved surface finish, reduction in cutting temperature, better chip forms and reduced cutting forces. Also studied method of aerosol spray, distance between nozzle and cutting zone, air and oil flow rate, air pressure, orientation of nozzle all plays a significant role in MQL application. However, to establish MQL as a feasible alternative to flood cooling, research should be directed to also measure the mist level and droplet size as it seems that mist level is assumed lower than flood cooling without knowing the actual mist level.

M.W. Islam et al (2006) [2] have experimented that in the role of MQL on cutting temperature, chip formation and product quality in turning AISI- 1040 steel as a work material at different industrial speed-feed combinations by uncoated carbide as a tool insert. It has compared with dry machining and machining with soluble oil as coolant. From the study it is found that, the cutting performance of MQL machining is better than that of conventional machining with flood cutting fluid supply.

M.M.A. Khan et al (2009) [7] have experimented that 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. In this work, AISI 9310 steel used as a work material and uncoated carbide used as a tool insert. From the experiment it is found that, MQL has most significant on chip formation modes, tool wear and surface finish.

Murat S. et al (2014) [5] have determined that the effects of process parameters on surface quality in turning operations by Taguchi analysis and RSM using as a AISI 1050 steel work material and as a TiAlN coated carbide tool material. In this work, cooling condition, cutting parameters are cutting speed, feed rate and depth of cut. Experiments have been performed under dry cutting, conventional wet cooling and MQL. Experiment is designed and conducted based on Taguchi's L16 (4^3*2^1) orthogonal array design. From the experiment it is found that feed rate and MQL are most significant factor on surface roughness.

M. A. Xavior, M. Adithan (2009) [4] have determined the influence of cutting fluids on tool wear and surface roughness during turning of AISI 304 with carbide tool. In their work, they are using coconut oil to reduce the tool wear and surface roughness during turning process. The performance of coconut oil is also to be compared with another two cutting fluids, they are soluble oil and Straight cutting oil. Experiments are designed and conducted based on Taguchi's L27 Orthogonal array design. Controlled factors include cutting speed, feed rate, type of cutting fluid and depth of cut in straight turning of AISI 304 austenitic stainless steel bars using carbide tool. After the Analysis of Variance was made, it is found that feed rate has got the greater influence on surface roughness.

III. CONCLUSIONS

The above literature suggests that cutting fluids are evolving quickly as eco friendly fluids giving ideal outcomes for various machining operations with correlation with dry machining. The ability of a liquid relies on upon the sort of machining procedure and work piece material for which the liquid is being utilized. As of late, MQL system is much of the time utilized for better machining performance.

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