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EFFECT OF MINIMUM QUALITY LUBRICATION ON VARIOUS PROPERTIES OF CUTTING PROCESSES

[1]Man Kumar, [2]DR. P.S Rao

[1]*M.E scholar, Department of Mechanical Engineering, National Institute of Technical Teachers Training and Research, (NITTTR),Chandigarh.*
[2] *Assistant professor, Department of Mechanical Engineering, National Institute of Technical Teachers Training and Research, (NITTTR), Chandigarh.*

ABSTRACT: In the last decades, the enhancement in coatings of carbide tools and in the chemical and mechanical property of tool materials, has caused the increase of tool working life in machining processes. This fact has permitted the use of the so-called dry machining technology and also machining with minimal quantity of lubricant. There are many important factors that justify the development of such technologies, including the high expenses of refrigeration, the ecological damages caused by the use of lubricants, the increasing law demands, related to the conservation of the environment, workers' health, etc.

KEYWORDS : MQL, MCQL, AISI 4340 steel, SEM analysis, multi genetic approach, Ti- 6Al-4V, aluminium silicon alloy (A356).

1. INTRODUCTION

A promising alternative to conventional fluid coolant application is minimum quantity lubrication (MQL). Despite much research, there have been few investigations about the influence of MQL parameters on the process results, such as oil flow rate, workpiece speed and depth of cut. The objective of this project is to develop a mathematical model of the material removal rate and surface roughness on grinding of ductile cast iron using minimum quantity lubrication[1].

Under MQL condition, the cutting parameters are different from those under dry cutting or wet cutting. A positive influence of the MQL method on surface roughness was confirmed in comparative studies of dry and MQL turning of AISI 1040 steel[2].

Minimum quantity lubrication (MQL) technique did not only serve as a better alternative to flood cooling during machining but enhance better surface finish, minimizes the cost, reduces the impact loads on the environment and health hazards on the operation personnel. However, the coolant or lubrication media used in MQL technique posed certain restrictions especially at very high cutting speeds where the lubricating oil tends to evaporates as it strikes the already heated cutting tool at elevated temperature[3].

The methods called Minimum Quantity Cooling Lubrication, MQCL, or Minimum Quantity Lubrication, MQL, are preferable options. In those methods, quasi-dry machining is effected, i.e. the quantity of the cooling and lubricating agent is lower than 100 ml/h [4].

The primary function of the MQL in metal machining operations is to serve as a coolant, also as a lubricant thereby reducing friction and tool wear. It is generally agreed that the application of MQL can improve the tool life and results in good surface finish by reducing thermal distortion and flushing away of machined chips. What is perhaps even more important is to ensure proper filtration of the fluid as suspended swarf can cause random deep scratches on the job[5].

2. LITERATURE REVIEW ON MINIMUM QUALITY LUBRICATION

Uysal et al. [6] The MQL method decreased the tool wear due to the information that the crushed cutting fluid was able to reach the interface between the cutting tool and workpiece. in addition, the MQL flow rate have positive effect on the tool wear.The MQL method gave better surface roughness than dry milling and the minimum surface roughness was measured as 0,8644 in nano MQL milling at 40 ml/h flow rate. The MQL method decreased the surface roughness by 8,8% and 22,5% for the flow rates of 20 ml/h and 40 ml/h, respectively when compared with the dry milling.

Deiaba and Pervaiza [7] executed study using MQCL (Minimum Quantity Cooled Lubrication) with bio degradable vegetable oil dry machining strategies. It was revealed that the tool life increased by 1.57 times under MQCL. MQCL also

offered lower cutting forces due to better cooling and lubrication performance along with 100% bio degradability and no tight effects like bad smell etc. The often projected use of vegetable oil as a machining lubricant in both MQL and MQCL configuration was tested in Titanium turning. It was found to be a more sustainable option to synthetic cooling in terms of tool wear, surface quality and cutting energy obsessive combined.

Rahim et al. [8] attempts to show the experimental results of using MQL based synthetic ester as the cutting fluid. Experimental research were passed out using orthogonal cutting process in which the competence of MQL technique was compare to dry technique with reverence to cutting temperature, cutting force, tool-chip contact length and chip thickness. The cutting temperature was reduced 10% to 30% for the MQL condition compared to dry condition. The reduction of temperature improved the tool life thus contributes to the sustainable manufacturing. Cutting force was reduced by 5% to 28% for the MQL condition compared to dry condition. This was due to the low coefficient of friction and smaller particle size that penetrates into the cutting zone. MQL machining technique was found to be more better than dry condition. This phenomenon can be correlate with the result of four ball test.

Dhara et al. [9] investigated the role of minimum quantity lubrication (MQL) on cutting temperature, tool wear, surface roughness and dimensional divergence in turning AISI-4340 steel at industrial speed-feed condition by uncoated carbide insert (SNMM 120408) and compare the usefulness of MQL with that of dry and wet machining.

The cutting presentation of MQL machining is better than that of dry and predictable machining with flood cutting fluid supply for the reason that MQL provides the remuneration mainly by reducing the cutting temperature, which improve the chip-tool contact and maintains unevenness of the cutting edges. MQL jet provided reduced tool wear, better tool life and better surface finish as compare to dry and wet machining of steel.

Khan and Dhar [10] suggests that the idea of MQL presents itself as a possible solution for machining in achieve slow tool wears while maintain cutting forces/power at practical levels, provided that the MQL parameters can be strategically tuned. The main objective of the at hand work is to experimentally investigate the roles of MQL by vegetable oil-based cutting fluid on chip tool interface temperature, cutting force, tool wear and surface coarseness in turning alloy steel (AISI 1060 steel) by the scientifically used uncoated carbide tool (SNMM 120408 TTS) at different cutting velocities and feeds combinations as compared to dry machining.MQL jet provides reduced tool wear, improves tool life and better surface finish as compare to dry machining of steel. Surface finish and dimensional correctness improved mainly due to drop of wear and damage at the tool tip by the use of MQL.

Radoslaw et al. [11] investigates about the impudence of mix mist cooling on the circumstances of heat combination from the machining zone.The cooling conditions under which the total number of drops falling on the hot surfaces of the machining zone fade away have been studied. The time of the drops vaporization is reduced proportionally to the reduction in single-drop diameter. This ensures the opportunity of regulating the process through adjust the mist creation conditions.

Attanasio et al. [12] the results obtained from turning tests and SEM analysis of tools, at two feed rates and two cutting lengths, using MQL on the rake and flank of the tool. The results obtain show that when MQL is applied to the tool rakeand tool life is generally not different from dry conditions, but MQL to the tool flank can increase tool life. Lubricating the rake surface of a tip by the MQL technique does not produce obvious wear reduction. Tool life time of a tip used in dry cutting conditions is alike to that of a tip lubricated by MQL on the rake. Lubricating the flank surface of a tip by the MQL technique reduces the tool wear and increases the tool life.

Najiha et al. [13] this research is for optimize the process of minimum quantity lubrication (MQL) in the end milling using multi-objective hereditary algorithm approach. The surface roughness, material removal rate and flank wear of the tool are the incompatible responses which are to be optimized. From among the feasible designs, Pareto designs are elected for auxiliary study. A multi-criteria decision making algorithm is run for the Pareto designs.

Zhang et al. [14] A series of limited element simulation have done for the process of form toroidal saddle parts using dissimilar lubricant and two kinds of rollers named damped rollers and ordinary rollers. The results show that the lesser the friction coefficient is, the easier the center of toroidal saddle part is stretched. Although the quality of formed parts is improved a lot by MRSF process, but the shaped parts are still not uniformly stretched when the curvature of the die is big. Enhance the lubrication can increase the mobility of sheet metal in the stretch forming process and make the spot inadequately stretched of the workpiece get a fully stretch.

Hegab et al. [15] The investigation are conceded out to study the induce surface class under different cutting design variables including cutting speed, feed rate, and added nano additive percentage(wt%).The innovation here lies on ornamental the MQL heat ability using nano tubes based fluid in order to get better Ti- 6Al-4V machinability. Due to the improved cooling and lubrication properties of the resultant nanomist, the tool wear performance has been significantly

enhanced because of the film formation along the chip-tool interface zone and consequently better surface quality has been talented.

Liu et al. [16] investigates the effects of different MQL parameters (air pressure, quantity of oil consumed, and position of the nozzle) in end-milling titanium alloy (Ti–6Al–4V). The trial results show that the piercing capacity of MQL oil mist has a significant effect on the milling forces and milling temperatures. Increasing the oil quantity will not get better the ability of lubrication. This will help to obtain the minimum quantity of oil utilization.

Zheng et al. [17] MQL method in micro-milling will considerably get better tool life and reduce substance bond. In order to study the manipulate of air fluid on micro-milling process, cutting vibration signal and surface morphology under different air fluid parameters were measured and analysed. Analysis results indicate that the air fluid direction of 180° and 0° aggravate tool vibration and lead to poor surface quality compared with the direction of 270° and 90°. MQL method can efficiently decrease cutting temperature in cutting zone. the surface coarseness under fluid direction of 0° and 180° is smaller than that of other directions.

Boubekri [18] Economical mass machining of common metals require facts of the work piece character as well as the optimal machining circumstances. In this study we investigate the effects of using MQL and flood cooling in drilling 1020 steel using HSS tools with different coatings and geometries. The treatment selected for MQL in this study are commonly used by production under flood cooling for these materials. A full factorial experiment is conducted and regression models for both surface finish and hole size are generate. The outcome show a definite increase in tool life and better or acceptable surface quality and size of holes drilled when using MQL.

Nascimento et al. [19] to test the feasibility of minimum quantity lubrication (with and without water) in grinding of advanced ceramics, when com- pared to conformist method .calculated output variables were grinding power, surface roughness, roundness errors and wheel wear, as well as scan electron micrographs. The outcome show that minimum quantity lubrication with water (1:1) was superior to conservative lubrication-cooling in terms of surface quality, also reducing wheel wear, when compare to the other technique which tested.

Braga et al. [20] The main purpose of this work is to compare the presentation of the uncoated and diamond coated carbide drills, using minimal lubrication and rich soluble oil as a refrigerant lubricating the drilling of aluminum–silicon alloys(A356).The results showed an uneven wear in the surface of the diamond coated drill and a decrease in the quality of the hole made by it, compared to the uncoated drill. This conclusion proves the probable of using this method in the drilling process of aluminum silicon alloys.

3. CONCLUSIONS

MQL technique that decrease many cutting harms impending from high consumption of lubricant, like high machining costs or ecological and worker health problems. Therefore, it is imperative to know all reward and limits of this technique. The present work shows how MQL can be useful when cutting. Lubricating the rake surface of a tip by the MQL technique does not produce evident wear reduction. Tool life time of a tip used in dry cutting conditions is similar to that of a tip lubricated by MQL on the rake. Lubricating the flank surface of a tip by the MQL technique reduce the tool wear and increases the tool life. Traces of lubricant compounds have been found on the worn surfaces only when MQL has been applied on the flank surface. In conclusion, MQL gives some compensation during the turning operation, but it presents some limits due to the difficulty of lubricant success the cutting surface.

4. FUTURE WORK

This technology has a bright future. In coming years it may become better and better with application of cutting, finish and other manufacturing process. As we know that MQL is used to cool the surface of cutting and heat dissipation also, but in future MQL may serve the some other work like surface smoothness, improve surface quality as well as decrease heat generation in it minimum level so that the life of tool as well as work piece become more. Hence we can say that the MQL can serve better with some new experiments with less cost and more qualities.

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