EXPERIMENTAL INVESTIGATION OF MACHINING OF ALUMINIUM 7075 UNDER WET AND MQL TYPE LUBRICATING METHOD – A REVIEW

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ABSTRACT

In present time the technology of CNC vertical milling machine has been improved significantly to meet the advance requirements in various manufacturing fields, especially in the precision metal cutting industry, and to get the quality and better surface finish the use of lubrication while machining is necessary. So in most of the industries generally they use traditional method of lubrication like wet lubrication method. In which the amount of lubricant required more than the sufficient, due to which the amount of waste in the form of lubricant increases. Which may harmful to the environment as well as to the human life. To overcome this drawbacks now in some of the industries uses Minimum quantity Lubrication (MQL) technique over wet Lubrication technique. MQL is a micro lubrication technique that facilitates fine machining. It eliminates large quantities of water and mineral oil-based cutting fluids and replaces them with a small quantity of environment-friendly lubricant (mostly vegetable oils) mixed with air. In MQL-assisted machining, a small amount (10–250 mL/h) of cutting fluid is introduced to the chip-tool interface region along with compressed air, which acts as the carrier medium, as a replacement for several liters per hour of wet lubrication technique. So in this experiment we are going to compare the results of wet and MQL lubricating methods in the form of surface finish. This experiment is carried out on CNC Engraving machine by using the Aluminium 7075 as a work piece material. Aluminium 7075 due to its high strength, low density and thermal properties is vastly used in aircraft fittings, gears and shafts, aerospace applications, etc. In this experiment we are using Taguchi for the design of experiment which is mostly used for single optimization.

Keyword: - *Wet machining, Minimum quantity lubrication, CNC engraving machine, Taguchi.*

1. INTRODUCTION

CNC Engraving machine is one of the most commonly used in industry to machining on component's having hard flat surface by engraving on it to make designs which result may be decorated piece in itself. Decorated piece like jewelry, coining punch, Punching die, magazines, Printmaking and different decorative part which is used in automobile. So all this process required surface finish. Among different types of engraving processes of the most vital and common metal cutting operations used for machining parts because of its capability to remove materials at faster rate with a reasonably good surface quality (Yuma faujii et al. 2016). CNC Engraving process has been recently proved to be very versatile and useful machining operation in most of the modern manufacturing industries. Only the implementation of automation in Engraving process is not the last achievement. It is also necessary to optimize the process parameters for required quality (Alborz Shokrania et al. 2012) the surface roughness, material removal rate, machining time, power consumption, tool life, chips flushing are some of the quality parameters which required optimizing for the selected process parameters. For the Engraving machine, the different process parameters are spindle speed, feed rate, depth of cut, coolant, tool geometry etc. So in this experimental investigation we are focusing on lubrication method used while machining. In which generally traditional cooling

method are were used in industries, which have so many disadvantages. Firstly, the disadvantages of flood coolant are numerous, such as the high running cost of coolant pumps, maintenance of coolant systems, cleaning the work area of the machine tool and, particularly in summer or warm conditions, sometimes emitted by poorly maintained coolant systems. It is probably a common viewpoint in the machining industry that machine shops using traditional flood coolant require a high level of maintenance, not only in monitoring coolant condition but also clearing up spills from leaks that present a health and safety hazard in the workplace. Therefore, it would be ideal to implement dry machining, but the adverse effect on tool life, higher temperatures induced and lower performance makes it unsuitable in most cases.. Therefore, even where users have a defined dry cutting process, Minimum quantity lubrication (MQL) can potentially assist with extending tool life and increase machining performance in terms of surface finish, cutting forces and process capability. Minimum quantity lubrication (MQL) has increasingly found its way into the area of metal cutting machining and, in many areas and has already been established as an alternative to conventional wet processing. Minimum quantity lubrication today uses such precise metering that the lubricant is nearly completely used up. Typical quantities range from 5 ml to 50 ml per process hour if lubricant is supplied by means of a minimum quantity lubrication system (MQL system). Application of a targeted supply of lubricant directly at the point of use lubricates the contact surfaces between tool, work piece and chip. Therefor in this experimental investigation we are also going to compare the results of machining by using wet lubrications method and MQL lubrication method. This experiment will carried out on CNC engraving machine by using the Aluminium 7075 as a work piece material. In this experiment input parameter considered as speed, feed and depth of cut were output responses measured as a surface roughness and temperature while machining. For this we are using Taguchi for the design of experiment which is mostly used for single optimization.

2. LITERATURE REVIEW

R. Noorani and Y. Farooque (2008) the objective of this research was to study the effects of CNC machining processes on Aluminium alloy 6061 samples for its surface roughness. The main conclusion of this reason is that two factors highly responsible for the surface roughness are feed rate and tool size.

Bruce L. et al. (2016) this paper summarizes the advancements and challenges of minimum quantity lubrication (MQL) technology in automotive powertrain machining from both industrial and academic perspectives. MQL refers to applying a small amount of cutting fluid in the form of mist to the cutting zone rather than flooding the work piece. Two major challenges during MQL machining are limited cooling and chip-evacuation ability. The ultimate goal is to create a clean, sustainable, and high-efficient production environment, Cost saving, environment friendly.

Surasit Rawangwong et al. (2012) had tried to investigate the effect of process parameters on the surface roughness in Al 7075-T6 face milling. The optimal setting for the selected process parameters was speed at 2930 rpm and the feed rates at 808 mm/min. They also had given mathematical model for surface roughness in term of selected process parameters.

P.S. Sreejith et al. (2008) this paper reports on the effect of different lubricant environments when 6061 aluminium alloy is machined with diamond-coated carbide tools. The effect of dry machining, minimum quantity of lubricant (MQL), and flooded coolant conditions was analyzed. It is found that MQL condition will be a very good alternative to flooded coolant/lubricant conditions. MQL improving the quality of the work-piece surface and this process has got economic advantage.

Bharat Patel, 2012. The main objective of the experiment is to optimize the milling parameters (spindle speed, feed rate, depth of cut and cutting tool grade) to achieve low value of the surface roughness. The optimal condition for surface roughness in milling Aluminium was resulted at level 3 for spindle speed and it was 1200 rpm, at level 3 for feed rate and it was 500 rpm, at level 2 for depth of cut and it was 0.5 mm. The corresponding surface roughness is 1.034 μm.

E. A. Rahim et al. (2016) this paper using MQL based synthetic ester as the cutting fluid used. Experiment were conducted using orthogonal cutting process in which the efficiency of MQL technique was compared to dry technique with respect to cutting temperature, cutting force, tool-chip contact length and chip thickness. The experimental results showed that the application of MQL based synthetic ester as the cutting fluid was more efficient

for the machining process as it reduced the cutting temperature, cutting force, tool-chip contact length and produced better chip thickness compared to dry machining technique. 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.

Parveen Kumar and Deepak Chaudhary[10] (2013) According to this work mainly three cutting parameters named Spindle speed, Depth of Cut , Feed rate may be selected and optimize the Material Removal rate. The optimum value of MRR is 87.54 mm3/sec. obtained at Spindle speed 3500 r.p.m. & 0.6 mm of feed rate. So as we increase the Spindle speed & Depth of cut the MRR also increase.

Lutfi Taner Tunca et al. (2016) in this paper, the effects of MQL conditions on surface integrity in robotic milling of austenitic stainless steel are discussed. The surface integrity is assessed in terms of surface residual stress (XRD) and surface roughness (optical metallography), where MQL conditions for improved tool life is also investigated. The surface residual stresses can be decreased by well controlled MQL oil flow. The oil flow rate significantly affected the surface residual stress. The tool condition, i.e. flank wear and cutting heat affected zone, is significantly affected by lubrication settings. The most significant parameter was observed to be the duty cycle, which controls the oil flow rate. It was seen that increasing number of strokes per minute, i.e. increasing the oil flow rate, decreases the width of the cutting heat affected zone on the flank face. This can be associated with the heat barrier effect of thickened oil film, so that the heat transfer to the flank face decreases.

Ravikumar Kudaravalli et al. (2018) had optimized study of cryogenic machining method to improve the surface roughness and tool life and optimized cryogenic cooling system. Cryogenic machining, which uses liquid nitrogen as the cooling media, is considered a sustainable alternative to conventional flood cooling application used in the machining process. A brief review of the potential benefits and drawbacks of cryogenic machining is presented in this paper. Using factors as a guideline, an optimized cryogenic cooling system and tooling has been developed. The cooling system is optimized for flow quality, thermal insulation, controllability and safety. The innovative cryogenic cutting tool design utilizes built-in coolant channels to achieve the optimal process performance. This solution incorporates outstanding cooling capability for optimal performance, while minimizing or eliminating the adverse effects.

S. Minl I. et al. (2005) had optimized study, the adsorption characteristics of MQL media during orthogonal cutting was investigated using two experimental setups; one in a high vacuum chamber with a mass spectrometer to observe mass changes of MQL media during cutting, and another setup in an atmospheric chamber where the supply of MQL media can be controlled on alloy steel (S45C). Main Objective of paper is used MQL Lubrication system and compare with conventional flood supply machine. Performance is almost same but by using MQL system to achieve both environmental and ecological benefits. Result was obtained Better surface finish, tool life increase, Increase lubrication characteristic.

3. RESEARCH FINDINGS

In present time the technology of CNC vertical milling machine has been improved significantly to meet the advance requirements in various manufacturing fields, especially in the precision metal cutting industry. To improve the cutting speed generally there is huge use of traditional fluid as lubrications used. Due to which large amount of waste formed in the form of waste fluid, which may harmful to peoples in many ways. The entire government agency forcing industrialist to reduce the use of harmful cutting fluids because this fluid damage the ecosystem. Vegetable oil is a Non-edible categories like Jatropha oil etc. This oil can reduce cutting temperature 10 to 30% by using MQL process compared to Dry machining process. It also reduce cutting force 5 to 28% compared to dry machining process. All this researchers studied the concept about dry, wet, MQL, cryogenic cooling system over the different materials. The objectives of this research papers is to review, which are used for the quality and productivity improvement using the CNC machining. Detailed research is required to reduce losses to improve the productivity of the operation. The plan is to obtain better surface finish by while increasing the material removal rate and productivity choosing right values for input parameters. All companies require better quality of surface finish with better utilization of the capacity to improve the productivity. In order to have best results, it is required the development of new materials, in wet machining MQL cooling process and new coatings for the cutting tools for dry

process. MQL is one of the best cooling method to obtained better surface finish. But industry has no information about MQL process and it is require educating to all about cooling process. So the aim of this paper is to review the cutting process by applying the right input parameter and measure output responses as Ra value and temperature after each experiment. And compare the results for wet and MQL and suggest the well input parameter for machining of Aluminium 7075 on vertical engraving machine.

4. CONCLUSION

This paper compares the effect of the different input cutting parameters on the surface roughness and temperature. Cutting and cooling applications play a major role in manufacturing operations. The process parameter and the final work piece can be improved through the application of lubricants. Dry machining cooling capacity is limited to achieve best result and also generate more amount of heat while machining, and also tool required special coating material which is costly process, therefore wet machining was seen as a good alternative. By using different material researcher obtained best result using MQL process with vegetable oil. Every industry shift to use vegetable oil for cutting fluids which reduces the amount of waste generation form traditional oil. Vegetable oil like Jatropha oil can reduce cutting temperature 10 to 30% by using MQL process and reduce cutting force 5 to 28% compared to dry machining process. By using MQL cutting chip can flush easily and chip size 3 to 9%thinner than dry machining. MQL performance is better as well as achieves both environmental and ecological benefit. On the other hand, wet machining though expensive but have good lubricating properties and pose less threat to the environment. Based on the literature reviewed, It was found that MQL machining provided better results than wet lubricants with average cost.

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