NANO-PARTICALS REINFORCED MQL FOR ENVIORNMENTAL FRIENDLY MACHINING OPERATIONS.

Project Reference No.: *48S_BE_1543*

College : KLS GOGTE Institute Of Technology, Belagavi
Branch : Department Of Mechanical Engineering
Guide(S) : Dr. Mahantesh M. Nadakatti
Dr. Raviraj M. Kulkarni
Student(S): Mr. Vinayak Dadagol
Mr. Vishal Vijay Idalhondkar
Mr. Vitthal Ghasti
Ms. Vidyashree Santagol

Keywords:

Nano-Particles, Minimum Quantity Lubrication (MQL), Eco-Friendly Manufacturing, Sustainable Manufacturing, Lubrication Technology, Nanotechnology.

Introduction:

In a machining process, in order to improve machining efficiency, reduce the machining cost, and improve the quality of machined parts, it is necessary to select the most appropriate machining conditions. The setting of machining parameters relies strongly on the operator's experience. It is difficult to utilize the highest performance of a machine. owing to their being too many adjustable machining parameters. The higher material removal rate and the smoother surface are preferred in machining processes. However, the goals of high material removal rate and good surface finish quality are conflicting consequently; no particular combination of cutting parameters can be proposed to give simultaneously the best material removal rate and the best surface roughness. The growing demands for high productivity of machining require use of high cutting speed and feed rate. Such machining inherently produces high cutting temperature, which not only reduces tool life but also impairs the product quality. Hence, it is required to develop scientific methods for damage-free and economic machining of materials. Most of published works have focused on optimization of parameters for machining of metals.

Recently, the application of aluminium and its alloys in automotive and aerospace industries is widely growing. In machining of aluminium and its alloys, since they have highly adhesive characteristics compared with steels, more effective lubrication is often necessary, though they are not so hard. The cutting fluid for machining aluminium using traditional coolant-based methods is typically more costly than for other materials because the coolant have a higher concentration of oil in the mixture. Therefore, MOL would have massive benefits for machining aluminium, where dry machining is not appropriate. MQL machining has caught the attention of researchers and technicians in the field of machining as an alternative to traditional fluids. In this study, the gray relational analysis was used for optimizing the milling process parameters for the performance characteristics in face milling by using conventional cooling (CC) and MQL of 7075 aluminium alloy

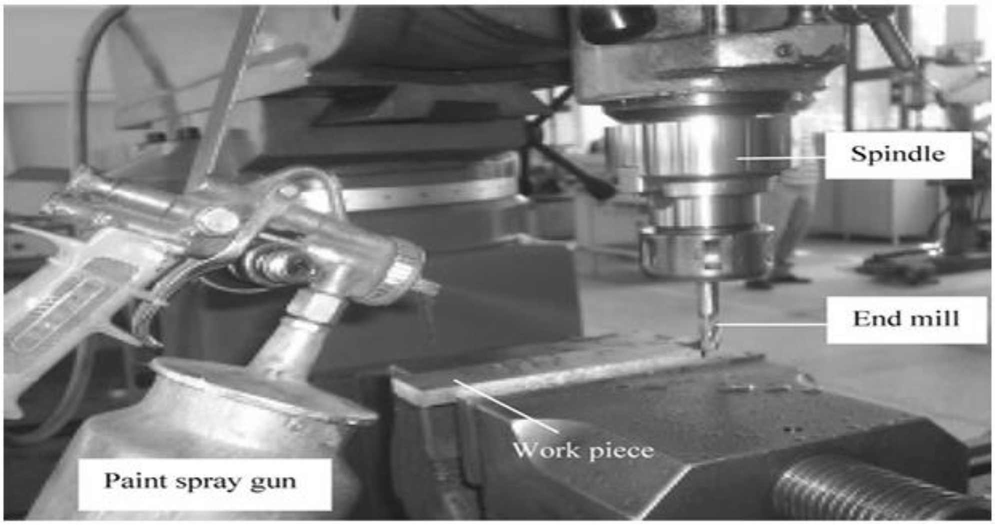

Figure 1: Minimum Quantity Lubrication System

Objectives:

- To improve the machinability of farm tools by using Minimum Quantity Lubrication (MQL) reinforced with Nano particles.
- To reduce the farm tool wear and reinforced with nanoparticle the lubricant oil Disposal increase its life by MQL system.
- To reduce or eliminate the cooling costs and reduce impact on environment.
- To completely eliminate used lubricant disposal (as only 50 ml of MQL needed) in place 500ml/hr of lubricant due to the application of MQL.

Methodology:

This project will assess the effectiveness of Nano Minimum Quantity Lubrication (Nano-MQL) in milling.

- **Problem Identification & Objectives:** Define the limitations of current methods and set specific goals for evaluating Nano-MQL (e.g., temperature reduction, surface finish improvement, lubricant reduction).

- **Resource Selection:** Utilize interdepartmental facilities (Mechanical & Chemistry) for nanoparticle synthesis (nanotechnology center) and experimentation (CNC VMC at VTU, Belagavi).

- **Preparation:** Synthesize and characterize nanoparticles, prepare Nano-MQL fluid, and design a structured experiment (Design Matrix) to vary cutting parameters and Nano-MQL application.

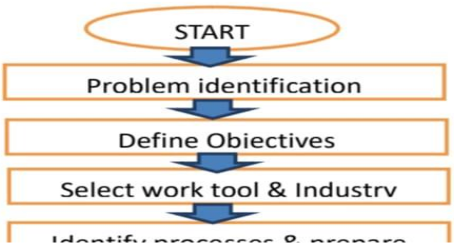

Figure 2 Methodology

- **Experimentation:** Conduct milling experiments on the CNC VMC using both conventional and Nano-MQL methods, carefully controlling cutting conditions.

- **Observation & Analysis:** Measure and record key performance indicators (temperature, surface finish, lubricant consumption). Analyze the data to compare the effectiveness of Nano-MQL.

- **Conclusion & Dissemination:** Draw conclusions based on the analysis and prepare a research paper for publication

Result and Conclusion:

Temperature Surface Finish Analysis:

Dry Machining:

- Depth of cut had the highest influence on temperature, ranking first, with a delta value of 8.23 for means and 2.00 for S/N ratios.
- Spindle speed had the highest influence on surface finish, with the highest delta values (1.7107 for S/N ratios).

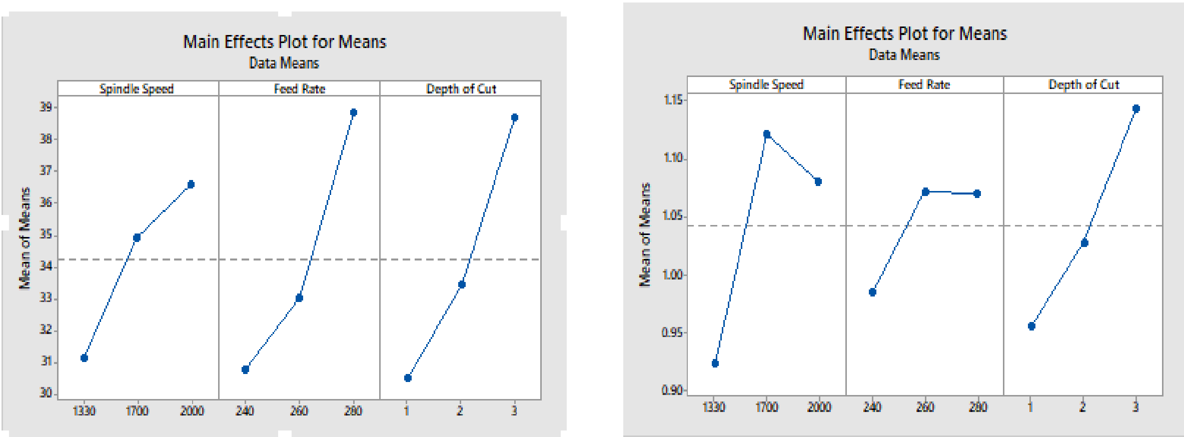

Figure 3.1 Means versus Spindle Speed, Feed Rate, Depth of Cut (Temperature and Surface finish for Dry)

MQL Machining:

- For temperature, Depth of cut remained the most significant factor (delta: 4.36 for means, 1.39 for S/N ratios).
- For surface finish, Depth of cut emerged as the dominant factor, with delta values of 2.6562 for S/N ratios.

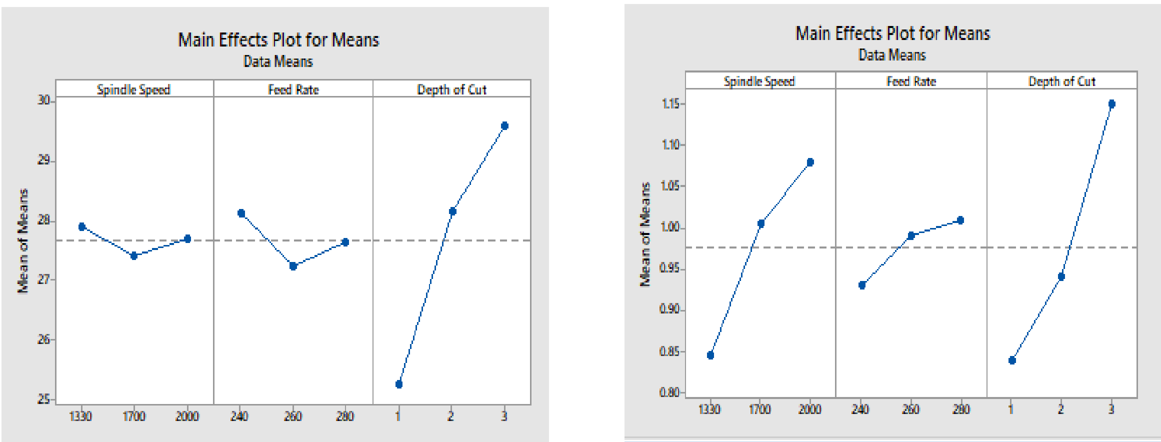

Figure 3.2 Means versus Spindle Speed, Feed Rate, Depth of Cut (Temperature and Surface finish for MQL)

Nano-MQL Machining:

- Depth of cut also ranked as the dominant factor (delta: 4.12 for means, 1.34 for S/N ratios).
- Spindle speed ranked second, indicating its stronger role under Nano-MQL conditions compared to MQL.
- Depth of cut had the highest influence, with delta values of 4.2167 for S/N ratios.

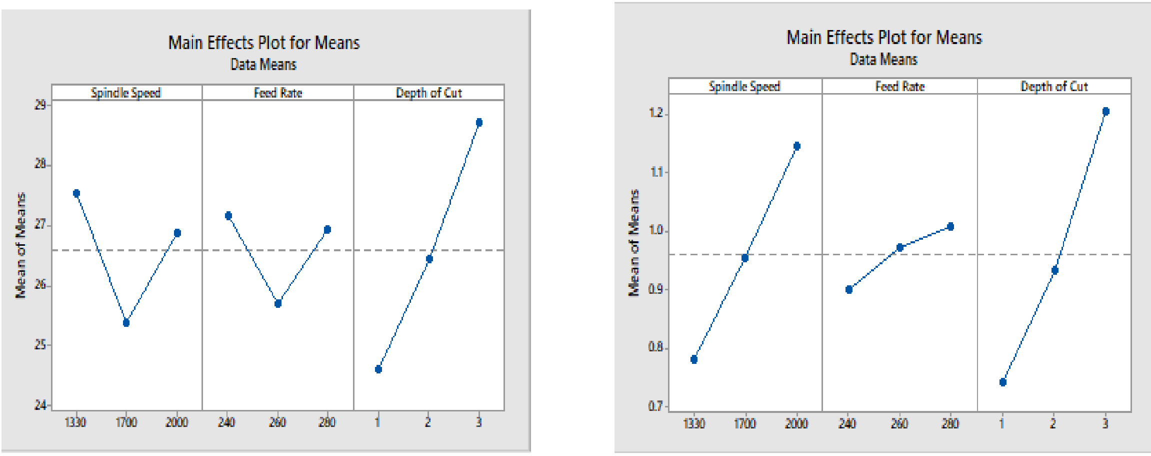

Figure 3.3 Means versus Spindle Speed, Feed Rate, Depth of Cut (Temperature and Surface finish for Nano-MQL)

Conclusion:

Temperature:

- Depth of cut is the most critical factor across all conditions.
- Nano-MQL machining provides the most effective temperature reduction, followed by MQL, and then dry machining.

Surface Finish:

- Surface finish improves significantly with lubrication. Nano-MQL achieves the best finish, followed by MQL and dry machining.
- Depth of cut remains the most influential factor in surface finish, followed by spindle speed.

Overall:

Nano-MQL machining is the most effective strategy for achieving optimal performance in terms of both temperature control and surface finish

Figure 3 Machined Material

Future Scope:

MQL:

- Widespread adoption: MQL is expected to become a standard machining practice across various industries, including aerospace, automotive, and medical device manufacturing.
- Improved tool life: Advances in MQL technology will focus on improving tool life, reducing tool wear, and enhancing surface finish.
- Increased use in difficult-to-machine materials: MQL will be applied to machine difficult-to-machine materials, such as titanium, Inconel, and advanced composites.
- Integration with other sustainable manufacturing technologies: MQL will be combined with other sustainable manufacturing technologies, such as dry machining, cryogenic machining, and hybrid machining.

Nano MQL:

- Enhanced machining performance: Nano MQL will continue to improve machining performance, reducing friction, wear, and heat generation.
- Increased use in precision engineering: Nano MQL will be applied in precision engineering applications, such as watch making, medical device manufacturing, and aerospace engineering.
- Development of new nano-lubricants: Research will focus on developing new nano-lubricants with improved properties, such as higher thermal conductivity, lower viscosity, and enhanced biodegradability.
- Integration with additive manufacturing: Nano MQL will be combined with additive manufacturing (AM) technologies to improve the surface finish and reduce post-processing requirements for AM parts.