



Experimental Investigation on the Effects of Nano Particles Suspended Coolant in CNC Machining

Mohamed Aslan S, Kishore C, Mohamed Yasar Arafat S

UG Student, Department of Mechanical Engineering, MAM School of Engineering, Siruganur, Trichy,
Tamil Nadu, India

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ABSTRACT: The "Hook" and Summary

- * Purpose: Provide a concise summary of the entire work.
- * Content: Briefly state the problem, the objective, the methods used, and the primary findings.
- * Length: Aim for 250–300 words. Since this is a full page, use a larger font for the title and include Keywords at the bottom to fill the space professionally. Austenitic stainless steel 304 is widely used in industries such as aerospace, automotive, and food processing due to its excellent corrosion resistance, toughness, and formability. However, machining this material—especially through CNC turning—presents challenges because of its high work-hardening rate, low thermal conductivity, and tendency to form built-up edges (BUE). Therefore, optimizing machining parameters is essential to improve productivity, surface finish, and tool life.

One of the key factors in CNC turning of SS304 is the selection of cutting parameters, including cutting speed, feed rate, and depth of cut. Lower cutting speeds are generally preferred to minimize heat generation and reduce tool wear, while moderate feed rates help in controlling surface roughness. Excessively high speeds can accelerate tool degradation due to the material's poor heat dissipation, whereas very low speeds may lead to BUE formation. Hence, a balanced combination of parameters is crucial. Tool material and geometry also play a significant role in optimization. Carbide tools, particularly those with coatings such as TiN or TiAlN, are commonly used due to their high hardness and heat resistance. Sharp cutting edges with proper rake angles reduce cutting forces and minimize work hardening. Additionally, chip breakers help in efficient chip evacuation, preventing damage to both the tool and the workpiece.

KEYWORDS: Nano particles, CNC machining, cutting fluid, coolant performance, surface roughness, tool wear, heat dissipation, machining efficiency, tribology, experimental analysis

I. INTRODUCTION

Foundation

- * Background: Explain the context of your topic. Why does this matter now?
- * Problem Statement: Identify the specific gap or issue you are addressing.
- * Objectives: List 3–4 clear goals your project aims to achieve.
- * Significance: Explain who benefits from this research or project. Austenitic stainless steel 304 (SS304) is one of the most commonly used engineering materials due to its excellent corrosion resistance, high ductility, and good mechanical properties. It is widely applied in industries such as chemical processing, food production, medical equipment, and automotive manufacturing. Despite its advantages, SS304 is considered a difficult-to-machine material, particularly in CNC turning operations, due to its inherent characteristics such as high work-hardening rate, low thermal conductivity, and strong tendency to adhere to cutting tools. CNC turning is a fundamental machining process used to form built-up edge (BUE), excessive heat generation, and poor surface finish. These issues not only increase production costs but also reduce the efficiency of the machining process.

II. LITERATURE REVIEW

The Context

- * Current State of Knowledge: Summarize what other experts or previous studies have said about this topic.



- * Theoretical Framework: Mention the theories or models that support your approach. 24
- * The Gap: Explicitly state what is missing from current literature that your work provides.

Kumar, Ashish, et al. "Nanofluids: A Review of Their Preparation, Properties, and Applications." *Journal of Cleaner Production*, vol. 259, 2020, pp. 1-18.

Saidur, R., et al. "A Review on the Performance of Nanoparticles Suspended with Refrigerants and Lubricating Oils in Refrigeration Systems." *Renewable and Sustainable Energy Reviews*, vol. 15, no. 1, 2011, pp. 310-323.

Zhang, Y., et al. "A Review of the Preparation, Properties, and Applications of Nanofluids in Machining Processes." *International Journal of Advanced Manufacturing Technology*, vol. 103, no. 5-8, 2019, pp. 2473-2495.

Sharma, P., et al. "Experimental Investigation of Nanofluids in Minimum Quantity Lubrication (MQL) Machining of Titanium Alloy (Ti-6Al-4V)." *Journal of Manufacturing Processes*, vol. 46, 2019, pp. 141- 152.

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Kumar, Ashish, et al. "Nanofluids: A Review of Their Preparation, Properties, and Applications." *Journal of Cleaner Production*, vol. 259, 2020, pp. 1-18.

III. METHODOLOGY

The "How-To"

- * Research Design: Are you using qualitative, quantitative, or mixed methods?
- * Data Collection: Describe your tools (surveys, interviews, sensors, or software).
- * Procedures: A step-by-step breakdown of how you conducted the work.
- * Visuals: This is a great place for a flow chart or process diagram to help fill the page.

IV. RESULTS AND DISCUSSION.

The Discovery

- * Findings: Present the raw data or outcomes clearly. Use tables or bullet points for readability.
- * Interpretation: Explain what the results mean. Do they support your original hypothesis?
- * Comparison: Compare your results back to the Literature Review (Section 3).
- * Limitations: Be honest about any constraints you faced during the process.

V. OPTIMIZATION

OPTIMIZATION OUTCOMES OF RSM AND BLACK WIDOW APPROACH

The optimization outcomes of process parameters using both RSM and Black widow optimization are discussed in Tables 5.25 and 5.26. The optimized machining responses obtained from both RSM and BWO methods are given in the tables 5.27 and 5.28. The contour plot for representing the optimal turning outcomes under different machining environments such as dry condition, N₂ gas application, MQL, MQL-hBN, MQL-AIN and MQL (hBN+AIN) are signified in the Figure 5.17 (a) to (f).

VI. CONCLUSION

The Final Word

- * Summary of Insights: Restate the most important takeaway from the project.
- * Recommendations: Provide actionable advice based on your findings.
- * Future Work: Suggest what the next steps should be for anyone continuing this research.
- * Final Closing Statement: A strong sentence that reinforces the value of the work.

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