International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Comparison and Analysis of Single Point Cutting Tool Under Different Rack Angle

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ABSTRACT

Single point cutting tools are indispensable components in machining processes, pivotal in determining precision, efficiency, and cost-effectiveness. This study endeavors to present an extensive comparison and analysis of various single point cutting tools, scrutinizing their geometries, materials, and performance attributes. Employing a systematic approach, this research amalgamates insights from existing literature, industry standards, and empirical data, supplemented by practical experimentation where feasible. Factors such as tool geometry (including rake angle, clearance angle, and cutting edge shape), material composition (e.g., high-speed steel, carbide, ceramic), and coatings (e.g., TiN, TiAlN, DLC) will be meticulously examined to discern their impact on critical performance metrics such as tool longevity, surface finish, and cutting forces. The outcomes of this study strive to offer engineers, machinists, and researchers well-informed guidance for choosing the optimal single point cutting tool tailored to precise machining requirements, with due consideration for both performance and cost factors. Ultimately, this research aims to improve machining efficiency, elevate quality standards, and promote sustainability across a wide spectrum of industrial sectors.

Keywords- Single point cutting tool, tool geometry, rake angle, cutting edge, surface finish

1. INTRODUCTION

Single point cutting tools serve as essential components within machining operations, holding pivotal significance in determining the efficiency, precision, and cost-effectiveness of a wide array of manufacturing processes. Employed across diverse sectors spanning automotive, aerospace, electronics, and beyond, these tools are instrumental in shaping and refining workpiece with utmost accuracy and reliability. The efficacy of machining endeavors hinges significantly upon the judicious selection and fine-tuning of single point cutting tools, taking into account crucial factors such as tool geometry, material composition, and machining parameters.

This research endeavors to offer a thorough comparison and analysis of single point cutting tools, with the aim of delivering valuable insights into their attributes, performance, and applicability across diverse machining tasks. Through a comprehensive examination encompassing tool geometry, materials, coatings, and their impacts on machining performance, this study aims to provide engineers, machinists, and researchers with a deeper comprehension of the factors underlying the efficacy of single point cutting tools

2. PROBLEM IDENTIFICATION

The process of selecting single point cutting tools poses a notable challenge due to the wide range of choices available and the need to precisely match tool characteristics with particular machining requirements. This complexity often perplexes engineers and machinists, impeding the efficient selection of tools and consequently affecting machining performance. Additionally, the variability in performance exhibited by single point cutting tools across various materials and cutting conditions further compounds the challenge. This inconsistency results in unpredictable machining outcomes, which hinder the achievement of desired efficiency levels and machining quality standards. Premature tool wear and restricted tool longevity exacerbate challenges in machining, leading to heightened downtime, increased replacement expenses, and reduced overall machining efficiency. Resolving this issue requires the formulation of strategies aimed at prolonging tool lifespan and alleviating the negative impacts of wear on machining processes.

3. OBJECTIVES

According to the Single point cutting tool industry's requirement, the following research outputs have been met,

1. Conducting an in-depth comparative analysis of diverse single point cutting tools, encompassing variations in geometry, material composition, and coatings.

2. Examining the performance attributes of single point cutting tools, such as tool longevity, surface finish quality, and cutting forces, across a spectrum of machining conditions.
3. Investigating the impact of tool geometry, material composition, and coatings on key machining performance metrics to understand their influence on overall tool effectiveness.
4. Identifying the factors contributing to the variability in single point cutting tool performance across different materials and machining conditions, aiming to uncover patterns and optimize tool selection.
5. Exploring effective strategies to extend the lifespan of cutting tools and mitigate the detrimental effects of premature wear on machining operations.

4. METHODOLOGY –

This study aims to systematically investigate the cutting forces in an orthogonal turning process, considering the variables of rake angle and depth of cut. The research entails the turning of three cylinders made from diverse materials—EN 31, MS, and aluminum—utilizing both HSS (Miranda) and carbide tools at various rake angles (0, 4, 8, 12, 16 degrees). Each rake angle will undergo testing with nine distinct depth cuts, ranging from 0.2 to 4.5 mm, while maintaining a constant cutting speed of 550 rpm. Precise measurements of cutting forces will be conducted using a dynamometer during the experiment.

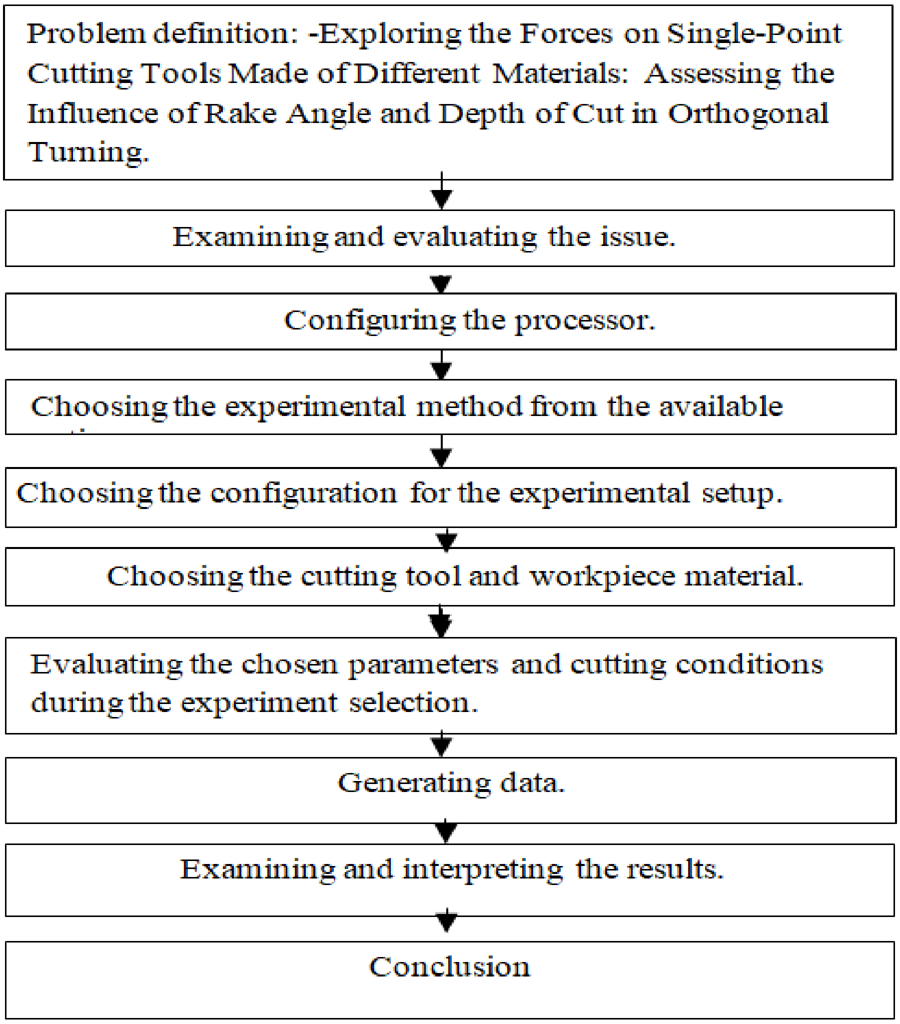

Figure 4.1 Methodology

5. RESULT AND DISCUSSION

As shown in figure 5.1 with increases rake angle, cutting forces decreases for EN 31and MS work materials while for Aluminum work material, cutting forces increases with increases rake angle with Carbide tool.

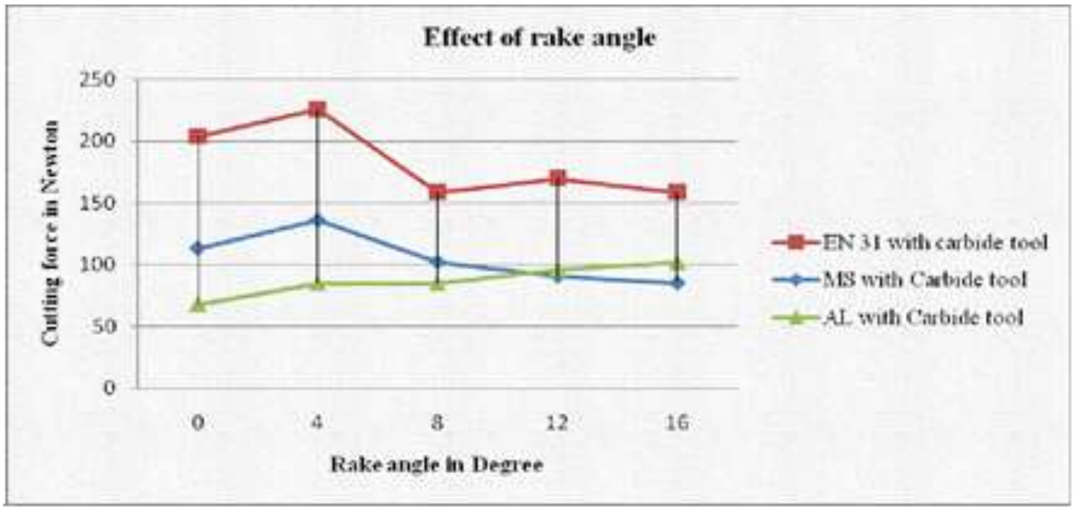

Figure 5.1 Effect of rake angle on AL, MS, EN31with Carbide tool

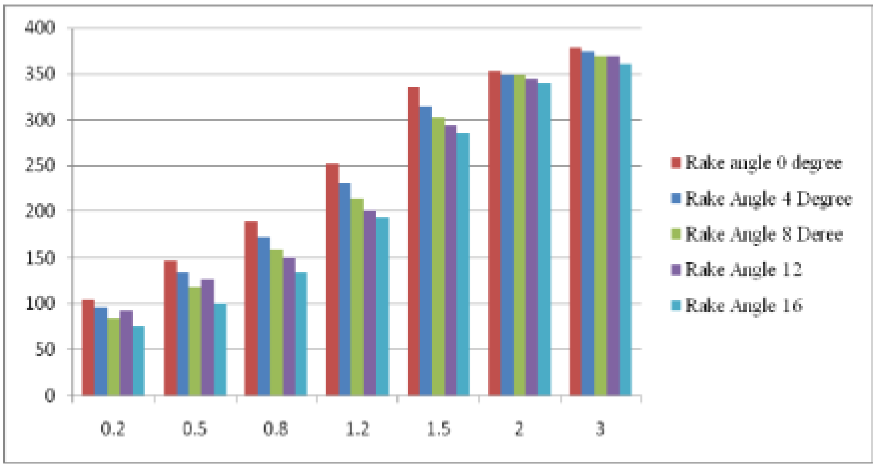

Fig. 5.2 Cutting force at different Rake angle on EN 31

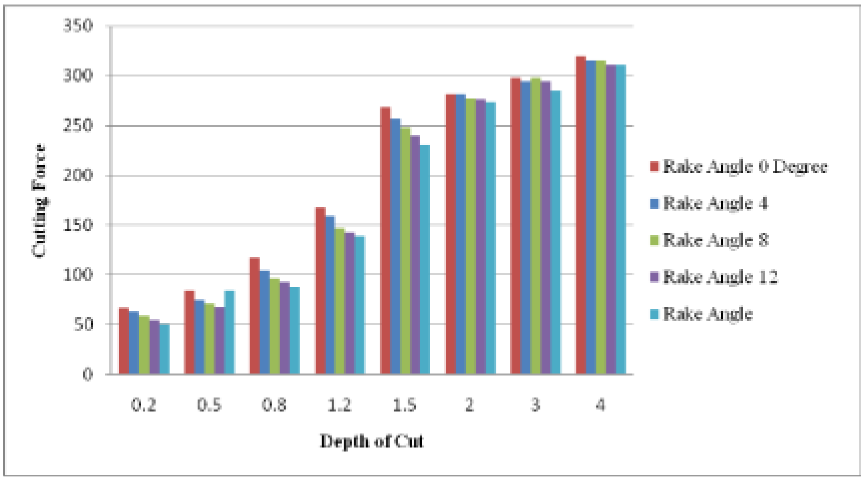

Fig. 5.3 Cutting force at different Rake angle on MS

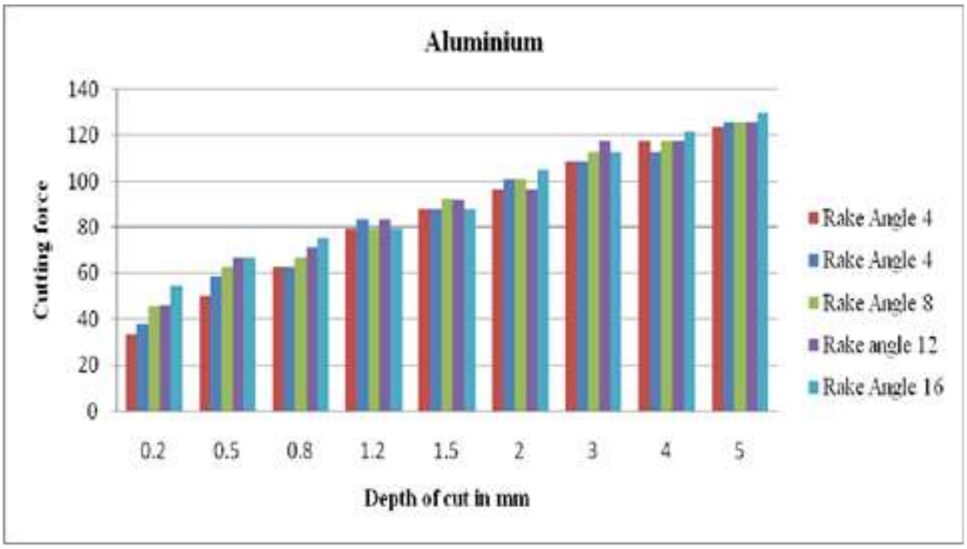

Fig. 5.4 Cutting force at different Rake angle on AL

6. CONCLUSION

With increasing rake angle cutting forces decreases on EN 31, MS while increases cutting forces on aluminum for small depth of cuts and unchanged for (1.5 mm to 5mm). For same depth of cut the cutting force value is more in Carbide tool than HSS tool. When depth of cut increases above 3 mm in EN31 material noise and vibration produced. In Aluminum material 5 mm depth of cut can be turned with HSS tool and Carbide tool, Mild Steel material turned up to 4 mm depth of cut with HSS tool and up to 5 mm depth of cut with Carbide material but in EN 31 material more than 3mm depth of cut cannot be turned with HSS tool and not exceed more than 4 mm depth of cut with Carbide tool.

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