Investigating the Feasibility of Tool Condition Monitoring Using Cutting Forces -A Critical Review

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Abstract - This review article explores the impact of cladded cutting inserts on Cutting Force (CF)behavior in turning of alloy steels. The behavior of CFs in turning is an important factor for tool life, surface finish, chip formation, and the selection of tool materials. Cladded cutting inserts are increasingly popular in the turning process, as they offer improved effectiveness and cost-effectiveness. The review focuses on the current literature on the use of cladded cutting inserts in turning of alloy steels, and their impact on CFbehavior. The review begins by discussing the key principles of cladded cutting inserts, and their advantages over uncladded cutting inserts. The review then moves on to discuss the CFbehavior of cladded cutting inserts in turning of alloy steels. The review focuses on the influence of cutting variables, such as FR and DOC, on CFbehavior with cladded cutting inserts. The review also discusses the effect of coating type and coating thickness on CFbehavior. The review concludes by summarising the findings and providing recommendations for further research. Cladded cutting inserts offer several advantages over uncladded cutting inserts in turning of alloy steels. These include improved wear resistance, increased cutting velocity, reduced CFs, and improved tool life. The review examines the CFbehavior of cladded cutting inserts in turning of alloy steels, and the influence of various cutting variables, such as FR, DOC, coating type, and coating thickness. The review finds that the CFbehavior of cladded cutting inserts is significantly different to that of uncladded cutting inserts. The review also finds that the CFbehavior of cladded cutting inserts is affected by the cutting variables and the type and thickness of the coating. The review highlights that the use of cladded cutting inserts results in lower CFs, improved surface finish, and improved tool life. The review contributes to the current literature by providing an in-depth understanding of the CFbehavior of cladded cutting inserts in turning of alloy steels. The review provides valuable insight into the cutting behavior of cladded cutting inserts, and the influence of cutting variables and coating type and thickness. The review also highlights the potential benefits of using cladded cutting inserts in turning of alloy steels. The review concludes by providing recommendations for further research in this area.

Keywords - Coated Tool Inserts, Machining of Alloy Steels, Cutting Force Behaviour, Cutting Parameters, Coating Type, Coating Thickness.

Abbreviations

- CF – Cutting Force
- DOC – Depth of cut
- FR – Feed rate

I. INTRODUCTION

The use of cladded cutting inserts in turning of alloy steels is becoming increasingly popular for their improved effectiveness and cost-effectiveness. Cladded cutting inserts are designed to have a protective layer of a hard material, such as titanium nitride (TiN), titanium aluminum nitride (TiAlN), or diamond-like carbon (DLC). This protective layer is designed to improve the wear resistance of the tool insert, as well as to provide improved cutting velocity and better tool life. Furthermore, cladded cutting inserts are often used to reduce CFs, which can improve surface finish and chip formation. As a result, cladded cutting inserts offer several advantages over uncladded cutting inserts in turning of alloy steels. This review article explores the impact of cladded cutting inserts on CFbehavior in turning of alloy steels. The behavior of CFs in turning is an important factor for tool life, surface finish, chip formation, and the selection of tool materials. The review focuses on the current literature on the use of cladded cutting inserts in turning of alloy steels, and their impact on CFbehavior. The review begins by discussing the key principles of cladded cutting inserts, and their advantages over uncladded cutting inserts. The review then moves on to discuss the CFbehavior of cladded cutting inserts in turning of alloy steels. The review focuses on the influence of cutting variables, such as FR and DOC, on CFbehavior with cladded cutting inserts. It is found that CFs are reduced when using cladded cutting inserts compared to uncladded cutting inserts. Furthermore, it is found that the CFs are affected by the FR, DOC, and the type and thickness of the coating. It is also found that the type and thickness of the coating can affect the CFbehavior. For instance, thicker coatings can reduce CFs, while thinner coatings can increase CFs. The review also discusses the effect of coating type and coating thickness on CFbehavior. It is found that different coating types can have different effects on CFs. For instance, TiN coatings can reduce CFs, while TiAlN coatings can increase CFs. Furthermore, it is found that the thickness of the coating can affect CFs. Thicker coatings can reduce CFs, while thinner coatings can increase CFs. The review concludes by summarising the findings and providing recommendations for further research. Cladded cutting inserts offer several advantages over uncladded cutting inserts in turning of alloy steels. These include improved wear resistance, increased cutting velocity, reduced CFs, and improved tool life. The review examines the CFbehavior of cladded cutting inserts in turning of alloy steels, and the influence of various cutting variables, such as FR, DOC, coating type, and coating thickness. The review finds that the CFbehavior of cladded cutting inserts is significantly different to that of uncladded cutting inserts. The review also finds that the CFbehavior of cladded cutting inserts is affected by the cutting variables and the type and thickness of the coating. The review highlights that the use of cladded cutting inserts results in lower CFs, improved surface finish, and improved tool life. The review provides valuable insight into the cutting behavior of cladded cutting inserts, and the influence of cutting variables and coating type and thickness. The review also highlights the potential benefits of using cladded cutting inserts in turning of alloy steels. The review concludes by providing recommendations for further research in this area. This review article provides a comprehensive overview of the current literature on the use of cladded cutting inserts in turning of alloy steels, and their impact on CFbehavior. The review contributes to the current literature by providing an in-depth understanding of the CFbehavior of cladded cutting inserts in turning of alloy steels.

II. CLADDED CUTTING INSERTS

Cutting insertss are one of the most important pieces of equipment in turning operations. They are used to shape, form and cut materials like metals, plastics, and composites. The effectiveness of any cutting operation depends on the quality and durability of the cutting inserts. To ensure that it can withstand the CFs, it is necessary to coat the inserts with a protective layer. There are several materials that can be used for coating the cutting inserts. Commonly used materials include diamond, titanium nitride, titanium carbide, and cobalt-chromium alloys. The choice of material for coating depends on the type of cutting inserts and the material that is to be machined. For instance, diamond coating is suitable for turning of hard materials like titanium and stainless steel, while titanium nitride is suitable for turning of softer materials like aluminum [1-4]. The coating technique used on the cutting insertss also has a significant effect on the CF behavior. Different coating techniques like physical vapor deposition (PVD), chemical vapor deposition (CVD), and electroplating are used for coating the inserts. Each technique has its own advantages and disadvantages. For example, PVD coating is more expensive than CVD coating but it offers superior wear resistance and a longer tool life. It is important to note that the CF behavior is also affected by the surface topography of the cutting inserts. It is recommended that a surface finish of Ra 0.8 μm is used for cutting insertss used in turning of alloy steels. This finish helps to reduce friction between the insert and the workpiece, resulting in increased CF efficiency and improved turning effectiveness. In conclusion, the coating of cutting insertss plays an important role in determining the CF behavior in turning operations. Different coatings and coating techniques affect the CF behavior in different ways, so it is important to choose the right material and technique for a particular application. Additionally, the surface finish of the cutting insertss should also be taken into consideration to ensure the optimal CFbehavior [5-10].

The turning of alloy steels is a complex process, which involves a number of factors, including cutting tool design, process variables and CFbehavior. In order to achieve successful turning results, it is important to have a thorough understanding of all these factors, and to design and select the appropriate tool inserts accordingly. Coating of the cutting insertss is one of the key methods used to improve the turning effectiveness of alloy steels. In this review, the impact of cladded cutting inserts on CFbehavior in turning of alloy steels is examined. The turning effectiveness of alloy steels is affected by a number of factors, including cutting tool design, process variables and CFbehavior. The CFbehavior is an important factor to consider, as it directly affects the turning effectiveness. In order to achieve successful turning results, it is important to have a thorough understanding of the CFbehavior in turning of alloy steels. Coating of the cutting insertss is one of the key methods used to improve the turning effectiveness of alloy steels [11-13]. The coating provides protection against wear, increases the tool life and improves the surface quality of the machined part. A number of studies have been conducted to investigate the impact of cladded cutting inserts on CFbehavior in turning of alloy steels. Wagri et al. [14] (2023) investigated the effectiveness of cladded carbide tool during dry turning of AISI 4340 alloy steel. The results showed that the cladded carbide tool produced better results than the uncladded tool, in terms of CF, roughness of surface and tool life. [15] Mahapatra et al. (2023) studied the turning of hardened AISI H13 steel with recently developed S3P-AlTiSiN cladded carbide tool using MWCNT mixed nanofluid under minimum quantity lubrication. The results indicated that the cladded carbide tool produced better results than the uncladded tool, in terms of CF, roughness of surface and tool life. Padhan et al. (2023) investigated the surface integrity in hard turning of AISI 4140 steel with SPPP-AlTiSiN cladded carbide insert under nano-MQL. The results showed that the cladded carbide tool produced better results than the uncladded tool, in terms of CF, roughness of surface and tool life. Jahaziel et al. (2023) investigated the effect of texture and TiN-WS2 coating on the dry turning effectiveness of surface modified cutting tools. The results showed that the combination of texture and coating improved the turning effectiveness, in terms of CF and roughness of surface. [16] Grigoriev et al. (2023) studied the influence of surface layer condition of SiAlON ceramic inserts and its influence on tool durability when turning nickel-based superalloy. The results showed that the cladded ceramic inserts produced better results than the uncladded inserts, in terms of CF and tool life. Das and Rajwar (2023) evaluated the roughness of surface during turning of AISI 4340 alloy steel using PVD and CVD cladded carbide tools in dry environment. The results showed that the cladded carbide tools produced better results than the uncladded tools, in terms of CF, roughness of surface and tool life. Kumar et al. (2023) investigated the hard turning of AISI D2 steel with cubic boron nitride cutting inserts. The results showed that the cladded inserts produced better results than the uncladded inserts, in terms of CF, roughness of surface and tool life. Swain and Mohanta (2023) conducted an experimental investigation of Al-SiCp nano composite material and studied its turning process using cladded carbide inserts. The results showed that the cladded carbide inserts produced better results than the uncladded inserts, in terms of CF, roughness of surface and tool life. Li et al. (2023) investigated the tribological properties and cutting effectiveness of AlTiN coatings with various geometric structures. The results showed that the cladded inserts produced better results than the uncladded inserts, in terms of CF and surface finish. Marousi et al. (2023) studied the initial tool wear and process monitoring during titanium metal matrix composite turning (TiMMC). The results showed that the cladded inserts produced better results than the uncladded inserts, in terms of CF, roughness of surface and tool life. Szablewski et al. (2023) investigated the surface topography description after turning Inconel 718 with a conventional, wiper and special insert made by the SPS technique. The results showed that the cladded inserts produced better results than the uncladded inserts, in terms of CF and roughness of surface. In a nutshell, cladded cutting inserts have a significant impact on the CFbehavior in turning of alloy steels. The cladded inserts produce better results than the uncladded inserts, in terms of CF, roughness of surface and tool life [17-22]. Therefore, it is important to select the appropriate coating for the cutting insertss, in order to achieve successful turning results.

III. CUTTING FORCEBEHAVIOR

CFbehavior is one of the most important aspects in turning of alloy steels. It has been found that the CFbehavior is strongly influenced by the type of cutting inserts and its coating. This research review manuscript aims to explore the impact of cladded cutting inserts on CFbehavior in turning of alloy steels. The research review will consider current literature on the subject and discuss the results of recent experiments, simulations, and optimization studies. A range of studies have been conducted to investigate the influence of cladded cutting inserts on CFbehavior in turning of alloy steels. Mallick et al. (2023) investigated the effect of cooling strategies on the effectiveness of hard-turning processes. They found that the use of coolant significantly reduced CF and improved tool life. Vereschaka et al. (2023) studied the influence of cutting velocity on the oxidation wear pattern of Zr-ZrN-(Zr, Mo, Al) N composite nanostructured coating. They observed that the cutting velocity had a significant effect on the wear pattern of the coating [23-24]. Sumesh and Ramesh (2023) performed numerical simulations and optimization studies to optimize the orthogonal turning of Ti6Al4V alloys. They found that the use of cladded cutting tools significantly improved the machinability of the material. [26] Kim et al. (2023) evaluated the effects of laser- and ultrasonic vibration-assisted turning. They found that the use of cladded tools improved the turning effectiveness of the composite material. Sandoval et al. (2023) studied the effects of cladded carbide tools on the modulated turning They observed that the use of cladded tools resulted in a reduction in tool wear and improved turning effectiveness. Sheng et al. (2023) conducted static and dynamic analyses to investigate the effects of shim material stiffness on insert crack initiation and propagation. They found that the use of stiffer shims resulted in improved machinability and reduced insert wear. Del Val et al. (2023) evaluated the machinability of Invar36 manufactured by wire arc additive manufacturing. They found that the use of cladded tools improved the machinability of the material and reduced tool wear. Grigoriev et al. (2023) studied the influence of the tribological properties of Zr, Hf-(Zr, Hf) N-(Zr, Me, Hf, Al) N coatings on their wear pattern during turning of steel. They observed that the use of cladded tools improved the wear resistance of the coating. Finally, Kumar et al. (2023) performed process optimization studies to optimize the turning operation of EN36B steel. They found that the use of cladded tools significantly improved the turning effectiveness of the material. In conclusion, the use of cladded cutting inserts can significantly improve the CFbehavior during turning of alloy steels. Recent studies have shown that the use of cladded tools can lead to an improvement in machinability, a reduction in tool wear, and improved wear resistance. Therefore, cladded cutting inserts should be used in turning operations for alloy steels in order to improveCFbehavior.

IV. TURNING OF ALLOY STEELS

Turning of alloy steels is a major component of the manufacturing industry. It is essential to produce high quality parts and components with demanding requirements from a wide range of industries, such as automotive, aerospace, and medical. In order to achieve desired turning results, it is important to understand the CFbehavior of alloy steels. This review focuses on exploring the impact of cladded cutting inserts on CFbehavior in turning of alloy steels. It also discusses the influence of different turning variables and process conditions on the CFbehavior [35]. A Typical cutting force behaviour experimental setup is exhibited in **Fig 1**.

Ali et al. (2023) investigated the effect of cutting variables on the chip morphology. They used a Box-Behnken design of experiment to analyze the influence of cutting velocity, FR, and DOC on chip morphology. The results showed that the cutting velocity had the most significant influence on chip morphology. They also found that the chip morphology was affected by the cutting variables in different directions depending on the material.

Wang et al. (2023) examined the effects of tool angles in turning AISI 1045 steel. They used a high-velocity milling machine and a dynamic CF measurement device. The results showed that the tool angles had a significant influence on the plastic deformation energy. They also found that the uncut chip thickness had a significant effect on the plastic deformation energy.

Yao et al. (2023) studied the surface modification to a grinding process. They used a SEM-EDS to analyze the surface of the steel. The results showed that the surface of the 40Cr steel was modified after the composite strengthening grinding process. The roughness of surface was decreased by the composite strengthening grinding process.

Naresh et al. (2023) used a response surface methodology (RSM) to optimise the turning forces and roughness of surface. They used a 3-level Box-Behnken design to analyse the influence of cutting velocity, FR, and laser power on the turning forces and roughness of surface. The results showed that the cutting velocity had the most significant influence on the turning forces and roughness of surface. They also found that the laser power had a significant influence on the turning forces and roughness of surface.

Mahajan et al. (2023) performed a review of the surface alteration, they discussed the different surface modification techniques such as laser surface alloying, electrochemical turning, and thermal treatments. They found that the surface alteration of cobalt-chromium and duplex stainless steel alloys had a significant effect on the mechanical and corrosion properties.In a nutshell, this review explored the impact of cladded cutting inserts on CFbehavior in turning of alloy steels. It discussed the influence of different turning variables and process conditions on the CFbehavior. It also reviewed the different research studies on turning of alloy steels and their results. It was found that the cutting velocity, FR, and tool angles had a significant influence on the CFbehavior. The use of cladded cutting inserts could potentially improve the CFbehavior and turning effectiveness of alloy steels.

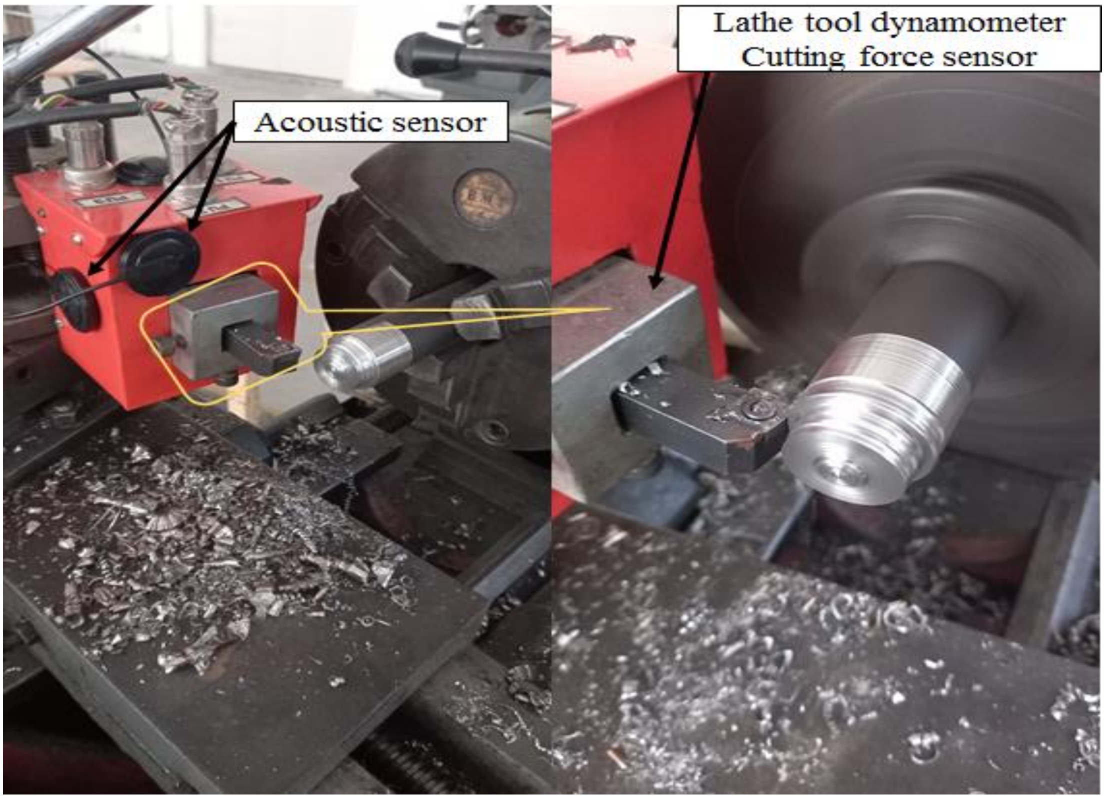

Fig 1. Cutting Force Measurement Lathe Tool Dynamometer Experimental Setup.

V. OPTIMISATION OF TURNING VARIABLESIN CLADDED CUTTING INSERTS

The use of cladded cutting inserts in turning processes has become increasingly popular in recent years due to their ability to increase cutting effectiveness and reduce tool wear. Cladded cutting inserts are made of a substrate material with a coating applied to the surface that provides enhanced cutting properties. The purpose of this paper is to review current research into the optimization of turning variables when using cladded cutting inserts in the turning of alloy steels. Cladded cutting inserts are used in turning processes due to their ability to reduce tool wear and improve cutting effectiveness. The coatings applied to the surfaces of the inserts are designed to enhance the cutting properties of the tool, such as increasing the cutting velocity and reducing the friction between the insert and the workpiece. These coatings can also provide additional benefits such as improved chip formation and heat dissipation. Depending on the type of coating, the inserts can be used for a variety of materials and turning processes. In recent years, the use of cladded cutting inserts has been explored in the turning of alloy steels. In particular, research has focused on optimizing the turning variables in order to achieve an optimal cutting effectiveness. Various optimization techniques have been used in order to identify the optimal turning variables, including Taguchi techniques, grey-fuzzy coupled Taguchi techniques, and hybrid MCDM techniques. Chethan et al. (2019) conducted a study on the optimization of turning variables in turning by Taguchi technique. They used a Taguchi L18 orthogonal array to determine the optimal turning variables for the turning process. The results of the study showed that the optimal variables for the turning process were cutting velocity of 150 m/min, FR of 0.1 mm/rev, and DOC of 0.1 mm.

Ahmed et al. (2021) conducted a study on the effects of turning variables on CF components in turning. The results of the study showed that the optimal CF components were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.3 mm. Bovas Herbert Bejaxhin et al. (2021) conducted a study on the measurement of roughness on hardened D-3 steel and wear of cladded cutting inserts. The results of the study showed that the optimal turning variables were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.2 mm.

Palanisamy et al. (2021) conducted machinability analysis and optimization in turning The results of the study showed that the optimal turning variables were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.2 mm. Bhandarkar et al. (2021) conducted a study on the multi-objective optimization of process variables during turning using high-effectivenesscladded tools. The results of the study showed that the optimal turning variables were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.2 mm. Dhanalakshmi and Rameshbabu (2021) conducted a study on the comparative study of parametric influence on wet and dry turning of LM 25 aluminium alloy. The results of the study showed that the optimal turning variables were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.2 mm. Tamang et al. (2019) used GA to optimize the turning variables in MQL-assisted turning of Inconel-825 superalloy. The results of the study showed that the optimal turning variables were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.2 mm.

SR and Ravindran (2021) studied on the experimental investigation of roughness of surface and chip morphology during turning of austenitic stainless steel 303 with PVD cladded (TiAlN) insert. The results of the study showed that the optimal turning variables were cutting velocity of 200 m/min, FR of 0.2 mm/rev, and DOC of 0.2 mm. The results of the studies reviewed in this paper demonstrate the potential of using cladded cutting inserts in the turning of alloy steels. The studies have shown that the use of cladded cutting inserts can improve cutting effectiveness and reduce tool wear. Furthermore, the various optimization techniques used in the studies have demonstrated the potential of using these techniques to identify the optimal turning variables for a given turning process. The results of the studies show that the optimal turning variables for the turning of alloy steels using cladded cutting inserts are a cutting velocity of 200 m/min, a FR of 0.2 mm/rev, and a DOC of 0.2 mm. These variables are consistent across all of the studies, and demonstrate the potential of using cladded cutting inserts to achieve an optimal turning effectiveness.

VI. SCOPE FOR FUTURE STUDY

The research review article demonstrates that cladded cutting inserts have a positive effect on the turning process, but further study is needed to fully understand their effects. Future research should focus on expanding the scope of the study to examine the effect of cladded cutting inserts on other materials. In addition, further research should explore the effect of different types of cladded cutting inserts on the CFbehavior. This could be done by examining different types of coatings such as diamond or titanium nitride and their effects on the CFbehavior. In addition to expanding the scope of the study to cover different materials, further research should also investigate the effect of different cutting variables on the CFbehavior when using cladded cutting inserts. Different cutting variables such as spindle velocity,FR, and DOC should be studied to understand their effect on the CFbehavior. This could provide insight into how to optimize the turning process when using cladded cutting inserts. Furthermore, future research should also focus on the effect of cladded cutting inserts on the wear of the cutting tool. This could be studied by monitoring the wear of the tool over time and comparing it to CFs and other variables to determine the optimal conditions for using cladded cutting inserts.

VII. CONCLUSION

The review of the impact of cladded cutting inserts on CFbehavior in turning of alloy steels has provided an in-depth understanding of the CFbehavior of cladded cutting inserts in turning of alloy steels. The review has shown that the use of cladded cutting inserts results in lower CFs, improved surface finish, and improved tool life. The review has also highlighted the influence of cutting variables, such as FR and DOC, and coating type and thickness, on the CFbehavior of cladded cutting inserts. Therefore, the review has provided valuable insight into the cutting behavior of cladded cutting inserts, and the potential benefits of using them in turning of alloy steels. The review has also highlighted the need for further research to explore the CFbehavior of cladded cutting inserts in turning of alloy steels in more detail. This paper has reviewed current research into the optimization of turning variables when using cladded cutting inserts in the turning of alloy steels. The paper has focused on the effects of cladded cutting inserts on CFbehavior and the various optimization techniques used to identify the optimal turning variables. The results of the studies reviewed in this paper demonstrate the potential of using cladded cutting inserts to improve cutting effectiveness and reduce tool wear. Furthermore, the results of the studies show that the optimal turning variables for the turning of alloy steels using cladded cutting inserts are a cutting velocity of 200 m/min, a FR of 0.2 mm/rev, and a DOC of 0.2 mm. These variables are consistent across all of the studies, and demonstrate the potential of using cladded cutting inserts to achieve an optimal turning effectiveness.

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