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# A Review Paper on "Experimental Studies and Performance Evaluation of Hard Turning Operation by Using Pcbn Tools"

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***Abstract:*** **-- The Quality of each and every hard turned part mainly depends on mechanical properties of the tool material and work piece material, In this research work the Multi-objective study of hard turning process parameters for obtaining greater hard turned material strength with good mechanical properties. The tool used for this study is PCBN tool and which is used on an EN8D workpiece. This EN8D material is widely used commercially for both continuous and interrupted machining modes which help us to study the parameters such as tool life, tool wear, tensile strength, depth of cut, micro geometry, turning speed, Angle of cutting etc.**

***Keyword*****: Hard Turning, Tensile Strength, turning speed, angle of cutting, depth of cut, tool life, tool wear.**

## I. INTRODUCTION

Hard Turning method has been widely used to reduce grinding operations and due to the development of very hard tool materials and very rigid machine tools which can ensure the same accurate geometrical and dimensional tolerances. Within the last years, hard turning operations have become more and more capable with respect to surface roughness and IT standards have little resistance against the typical shocks of interrupted cutting. On the other hand, interrupted surfaces are typical for turned parts, lending importance to the study of the turning of such surfaces in hardened steel parts. The main goal is to contribute to the studies turning experiments which were carried-out on various kinds of work piece surfaces and using tools with different CBN constituents and contents & different cutting edge micro geometries and final purpose was to find the best tool material and tool cutting edge micro geometry to turn continuous, semi interrupted and interrupted surfaces of hardened steel, in terms of tool wear and tool life

### 1.1 Hard Turning:-

The world is constantly striving for lower cost and waste solutions and to maintain performance on machined components and manufactured goods. Around the globe part quality has been found to be at acceptable levels and it continues to improve, while the pressure for part piece cost is enormous and is constantly being influenced downward by competition and buyer strategies. The trend is towards higher quality, lower cost and smaller batch sizes and to compete against producing countries with low wage structures, it is necessary to seek out appropriate new technological solutions that can help to level the business playing field and technology based tools such as 3-D CAD systems with computer programming and simulation packages and of course the CNC tools, are now commonplace in many shops and in most countries of the world and rapid adoption of newer and more cost effective manufacturing techniques are constantly required if manufacturing operations to remain competitive. The tools used for cutting are typically Cubic Boron Nitride and Ceramic. Tooling choice is a need to be matched to the application with desired production rates.

### 1.2 Requirements:-


***Fig no.1. Machine Requirements***

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**1.2.1 Machine Rigidity:**

To deliver the cutting performance required (accuracy, finish, extended tool life etc.) and working centers need to be of a rigid construction and good design. Composites such as polymers are base combined with wide-spaced, heavy-duty linear guides; super-finished tracks and centrally-located, short-pitch ball screws help reduce vibration and minimize stick/slip movement.

- Slides mounted on preloaded roll bearings guide ways
- Rigid tool holders system
- Specific chucking device designed to minimize the deformation on the part

**1.2.2 Part Rigidity:**

In attempting to hard turn a part that does not have sufficient inherent rigidity to withstand the cutting forces generated by the process. To understand whether parts are literally up to the job – it is recommended that we must consider the length (L): diameter (D) ratio of the part.

As a rule of thumb an L: D ratio of 4:1 for unsupported components and 8:1 for supported ones - produce optimum results. If the ratio is exceeded (for longer parts supported with a tailstock), it is likely that chatter will result.

**1.2.3 Kind of Tools required:**

High quality hard turning applications do require a properly configured machine tool and the appropriate tooling. For many applications, CBN tooling will be the most dominant choice. CBN tools are widely used for both continuous and interrupted hard turning applications as they deliver exceptional cutting performance with low wear.

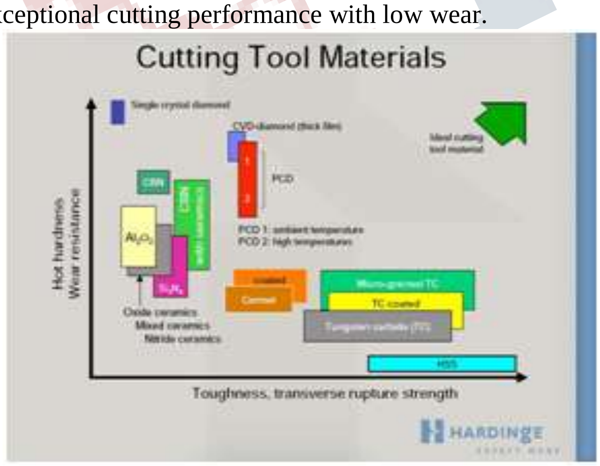


*Fig. No.2 Kind of Cutting Tool Materials*

**1.3 Process Parameter**

**1.3.1 Speed:**

Cutting speed is the speed difference between the cutting tool and surface of the work piece it is operating on. It is express in unit meter/min.

**1.3.2 Feed:**

Feed is the relative velocity at which cutting tool advanced along the work piece.

**1.3.3 Depth of cut:**

The thickness that is removed as work piece is being machined.

**Advantages**

A number of features of the hard turning process reduce environmental impact as well as cost.

Turning centers consume less electricity than grinding machines.

Price- Price of Hard Turning is very Low as compared to grinding operation ads up to greater productivity, better production control, shorter throughput and greater profits.

Flexiblitiy: we can both “soft turn” and hard turn on the same machine tool. Multiple operations can be machined with one set-up, resulting in less part handling and less

Limitations of Hard Turning

**Tooling**: - If we are considering the tooling material, it's important to understand the application and critical attributes such as size and finish requirements. The typical brazed tip CBN insert has a cost structure 3-4 times that of carbide Tool rigidity, tool placement, cutting tool geometry.

White Layer Formation: - The "white layer" can rear its ugly head in both hard turning and grinding operation Hard turned surfaces frequently experience "white layer" formation, which appears as a white layer at the surface of the material under metallographic examination and these are caused by either severe plastic deformation that causes rapid grain refinement or phase transformations as a result of rapid heating and quenching.

Machine Process Capabilities: Rigidity is a key and critical factor for successful hard turning: the rigidity of tooling, work holding, and the machine tool itself are all crucial elements that will affect your ability to successfully hard turn.

## II. LITERATURE REVIEW

HE Xinfeng, WU Su, Hubert Kratz (2010) investigated that For precision machining, the hard turning process is becoming an important alternative to some of the existing grinding processes. The cutting tool used is made from cubic boron nitride (CBN) with a wiper cutting edge. For validation, cutting forces predicted by the model were compared with experimental measurements, and most of the results agree quite well. Chaudhari Y D (2013) suggests that the three levels of each parameters viz. Hardness (HRC), Speed(mm/min), Feed(mm/rev) and three different tool materials are evaluated for process quality characteristics such as tool wear. The three different tool materials used are

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High CBN, Low CBN, Mixed ceramic. AISI H 11 was taken as work piece material. The experiment is designed using Taguchi Method. The results obtained from the experiments are transformed into signal to noise (S/N) ratio and used to optimize the value of tool wear. The analysis of variance (ANOVA) is performed to identify the statistical significance of parameters and Taguchi method is generally used to identify the best optimum parameter and find the factor, which is most effecting on the process. The most affecting parameter on tool wear is hardness which has impact of about 43.30%.

SThamizhmanii, K. Kamarudin, E. A. Rahim, A. Saparudin, S. Hassan(2011) investigates the tool wear and surface roughness of AISI 8620 material using coated ceramic tool by turning process. Surface finish is an important attribute in any machining operation. Surface roughness decreased when the cutting speed was increased and tool wear was not noticeable for a few tests. It increased rapidly at higher cutting speed, feed rate, higher depth of cut and increase in time. The flank wear, crater wear and nose wear were measured. During turning, built up edge formed and was due to diffusion of the work piece material

J. Kundrak, B. Karpuschewski, K. Gyani, V. Bana (2012) suggests that hard turning is frequently used to replace grinding. The most critical element in the accuracy of hard turning is the generation of out-of-roundness. In grinding, the flatness and axial run-out of the faces are critical, and this is about 4–5 times higher than in hard turning. With the given equipment and technology it can be hardly reduced. However, conicity on the entering side can be avoided with the overtravel of the wheel occurring in lower degree.

Wojciech Zębala, Jakub Siwiec(2012) suggests that Hard machining gives economical and qualitative benefits.. It should be noted that hard machining is not intended to exclude completely the grinding process in the machine parts manufacturing. This technology, despite many skeptical opinions is an alternative solution to improve significantly the economics of the machining process, increase productivity and shorten production time.

A. Attanasioa, D. Umbrellob, C. Cappellinia, G. Rotellac, R. M Saoubid (2012) investigates a series of orthogonal hard turning tests were conducted to study the effects of tool wear and cutting parameters (cutting speed and feed rate), on white and dark layer formation in hardened AISI 52100 bearing steel, using PCBN inserts the effect of cutting conditions and tool wear on the micro structural changes occurring at the machined surface by cutting speed, and the diffusion, heavily influenced by cutting temperature. On the other hand, the flank wear mechanism is mainly due to abrasive phenomena which are strongly affected by cutting speed.

P.H.S. Campos1, J.R. Ferreira, A.P. de Paiva, P.P. Balestrassi and J.P. Davim (2013) propses that Aunique behavior is on display in hard turning. It makes a variety of precision components with substantial potential benefits. The main factors affecting the reliability of hard turning are surface integrity and tool wear. The prediction of surface roughness, cutting force, and tool life in machining is a challenging task but necessary for proper optimization of the process. In hard turning, the Taguchi method and ANOVA have proved to be efficient tools for controlling the effect on tool wear and surface roughness. Response surface methodology (RSM) presented the desired criteria optimization for determining the relationship between the various factors (cutting speed, feed rate, and depth of cut) and the responses (cutting forces and surface roughness).

Alaattin Kaçal, Ferhat Yıldırım (2013) states high speed hard turning of hardened AISI S1 cold work tool steel with ceramic and CBN cutting tools and their performance were evaluated based on machining force, surface roughness and tool wear. Cutting speed, feed rate, depth of cut and tool types were determined as processes parameters. CBN cutter exhibited a better performance than the ceramic cutter. The increase in the feed rate value increased the roughness for both cutters. With regards to turning operations, a roughness value of approximately 0.2 μm was obtained, which is very good. Duong Xuan-Truong, Tran Minh-Du (2013) states by taking into account the Analysis of Variance (ANOVA) in accordance to Central Composite Design (CCD); the mathematical model of the flank wear and surface roughness are developed with transformation of the natural logarithm and revealed that the cutting speed is the most significant effect to the flank wear; whereas the surface roughness is strongly influenced by the feed rate and slight related to the tool wear mechanisms. In particular, the surface roughness tends to decreased with the increased of the cutting speed when the built-up-edge was disappeared. However, the tool wear increased rapidly when the cutting speed increased over 90 m/min. This phenomenon is therefore inevitable affected to the tool life and the machined surface quality.

## III. PROBLEM STATEMENT

The aim of this review is to study various parameter and for the PCBN tools, and from the Previous work one thing is clear that the three is very few work in the area of comparison of turning process parameters like Turning Speed, angle of cutting, working conditions and surface hardness on the attributes like tensile properties like stress strain, micro geometry and depth of cut. This tensile strength of specimen tool is most commonly affected due to

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working parameters so in this project work Increase of tensile strength, Microstructure refinement are carried out

## IV. METHODOLOGY

The methodov used is using two different methods in it which are Taugachi Experimental technique and Microstructural methods and the Multi objective analysis on the basis of Various Input parameters and output parameters. Multi-objective analysis is also known as multi-criteria or multi-attribute analysis is the process of simultaneously optimizing two or more conflicting attributes (objectives) subject to certain constraints.
The Material used will be EN8D and tools used are PCBN tools and whole experimentation will be performed on CNC Machine to reduce errors. The Input parameters which will be considered are Depth of Cut, Speed and Feed and the output parameters which will be studied are tool wear, chip reduction coefficient, power consumption and surface roughness.

## V. POSSIBLE OUTCOMES

We can get reduced surface roughness, reduced tool wear, increased tool life and many more improved mechanical properties which will lead to a good and efficient hard turned product which will improve the performance capabilities.

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