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Study of Mechanical Properties of Workpiece Machined Using Inserts of Various Geometries – A Review

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ABSTRACT: Turning is a conventional machining process where the material is removed using lathe. The machining is done mainly using HSS tool in older days, in present scenario use of inserts come into existence which has improved the surface finish, machining time and productivity. The inserts have improved the life of the tool and has more temperature withstanding capacity and high hardness. Nowadays material of the size 10^{-9} m known as the Nano materials are coated to improve the surface characteristics of hard and brittle material. Nano particles are coated on the cutting tool to improve the surface roughness value and to increase the tool life. The main objective of our project is to study the mechanical properties of the mild steel workpiece that had been machined by the inserts having various internal angles which are nanocoated with nickel. The two different geometric inserts chosen for the turning operation are TNMG & WNMG. We also compare the properties of these two inserts with another insert known as CNMG. The internal angles of the inserts TNMG & WNMG are 60° & 80° respectively. The mechanical properties that we had taken into account are machining time, surface hardness & type of chip. Variation in mechanical properties with respect to the change in machining parameters such as speed, feed & depth of cut are studied. Therefore, the experimental study presented here shows the variation in mechanical properties of workpiece machined by nickel nano coated inserts, on the basis of various machining parameters.

KEYWORDS: Inserts, nanomaterial coating, internal angles, mechanical properties, machining parameters.

I. INTRODUCTION

Machining is one of the various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. Turning is an engineering machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical tool path by moving more or less linearly while the workpiece rotates. Inserts are removable cutting tips, which mean they are not brazed or welded to the tool body. The turning operation is performed using a high hardness and a high temperature withstanding material so that the turning of the products is possible, this produces a good surface finish product and the time required for machining is reduced.

Inserts are usually [index able](#), meaning that they can be rotated or flipped without disturbing the overall geometry of the tool. The angle inside two adjacent sides of a polygon is called internal angle of an insert. In geometry, an interior angle is an angle formed by two sides of a polygon that share an endpoint.

II. NANO TECHNOLOGY

Nano science involves research to discover new behaviours and properties of materials with dimensions at the nano scale, which ranges roughly from 1 to 100 nano meters (nm). Nanotechnology is the way discoveries made at the nano scale is put to work.

Nanotechnology is more than throwing together a batch of nanoscale materials—it requires the ability to manipulate and control those materials in a useful way.

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III. LITERATURE SURVEY

Prasanna Gadhari, Prasanta Sahoo studied Ni-P-Al₂O₃ composite coating developed by electroless process by varying the content of nickel sulphate, sodium hypophosphite and investigated the effect of alumina content on the surface morphology, roughness, hardness, friction, and wear and concluded that Co-deposition of alumina particles within Ni-P coating matrix changes the roughness and the surface morphology of composite deposits from a smooth state to a non-smooth state. The hardness, coefficient of friction and wear resistance of Al₂O₃ composite coatings increase in the presence of Al₂O₃ particles, whereas the maximum hardness and wear resistance are achieved in heat treated coating at about 400°C. Abrasive wear is the most dominant mechanism for wear of Ni-P-Al₂O₃ coatings

R. Abdel-Karim and A. F. Waheed studied Nano structured Ni-Fe alloys, produced by electro-deposition technique and concluded that provide material with significant improved strength and good magnetic properties, without compromising the coefficient of thermal expansion

Jothi Sudagar, Jianshe Lian, Wei Sha studied different electroless nickel alloy, composite, nano plating, bath techniques, preparation, characterization, new depositing mechanism and concluded that The properties of electroless nickel coatings are improved continuously by suitable surface treatments (heat, laser, etc.) and the incorporation of various elements (copper, tungsten, etc.) and particles (SiC, TiO₂, etc.) by the various researchers to suit the various applications. Ron Parkinson studied Electroless nickel plating and concluded that properties that have contributed to the success of electroless nickel include corrosion and wear resistance, hardness, magnetic response, solderability, lubricity and thickness uniformity.

Sanjib Kundua, Suman Kalyan Dasa and Prasanta Sahoo studied properties of electroless nickel and found that as-deposited Ni-P coatings outperform heat treated ones in case of wear resistance at elevated temperatures. Addition of a third element (silver) or particle (SiC, MoS₂, BN, etc.) also influences the elevated temperature performance of EN coatings.

Li Zhou studied Machining Chip-Breaking Prediction with Grooved Inserts in Steel Turning I detail and concluded that the Quality, productivity, cost, and environment are four main concerns in manufacturing. Chip control is very important in optimizing the manufacturing process. To achieve the chip control goals in industry, chip-breaking predictive tool is crucial. The semi-empirical approach could be a powerful way to reach that goal. It bridges the existing gap between theoretical work on chip-breaking prediction and industry requirements. The chip-breaking limits theory is the basis of the semi-empirical approach. Once the predictive model of the chip-breaking limits is set up, chip-breaking can be predicted. In this research semi-empirical chip-breaking models are developed for two-dimensional grooved inserts and three-dimensional grooved inserts. The models are integrated into the web-based chip-breaking predictive system for online use in industry.

Nikunj Patel, Prof. R. K. Patel, Prof. U. J. Patel, Prof. B. P. Patel studied Insert Selection for Turning Operation on CNC Turning Centre using MADM Methods in detail and concluded that The proposed MADM method, the AHP, RAHP and TOPSIS applied for selection of a suitable tool insert from number of alternatives. The ranking of tool insert based on its performance score (i.e. tool insert selection index) for all three methods is 3-4-1-5-2 which is same all three methods. So, from the ranking of three MADM methods we found that tool insert 3 i.e. DNMG 15 04 12 PF is the best tool insert for better surface roughness in turning of alloy

Steel.T.Tamizharasan, N.Senthil Kumar studied Optimization of cutting insert geometry using deform-3D: Numerical simulation and experimental validation in detail and concluded that the optimum condition obtained is cutting insert shape D (Diamond 55°), relief angle of 7° and nose radius of 0.8mm, for D shape, the interface temperatures, interface pressure, wear depth and resultant cutting forces are minimum, as the nose radius increases, the wear depth decreases and the cutting forces also decreases, hence it is concluded that for machining AISI 1045 steel, the cutting insert with less included angle with a nominal relief angle and medium nose radius will be beneficial. M. Subramanian, R. Sivaperumal, M.P. Siva, M. Sakthivel studied Using RSM and GA to Predict Surface Roughness Based on Process Parameters in CNC Turning of AL7075-T6 in detail and concluded that the response surface methodology is applied to develop a second order mathematical model that can be used to predict the surface roughness value for known values of tool nose radius, cutting speed and feed rate in CNC turning. The adequacy of the model is examined using ANOVA. The direct and interaction effect of the input parameters are also analysed. Also the mathematical model is optimized

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using Genetic Algorithm to attain minimum surface roughness. The predicted values of roughness are found to match closely with the observed values. Rishu Gupta, Ashutosh Diwedi studied Optimization of Surface Finish and Material Removal Rate with Different Insert Nose Radius for Turning Operation on CNC Turning Center in detail and concluded that the Turning tests were performed on Aluminium Alloy 6061 work piece using three different carbide insert of varying nose radius. The influences of cutting speed, feed rate, depth of cut and nose radius were investigated on the machined surface roughness and Material Removal Rate (MRR). Virender Singh, Tasmeem Ahmad Khan studied Comparative Performance Analysis of Insert Geometry for Turning Operation on CNC Turning Centre in detail and concluded that The analysis of the experimental observations highlights that MRR in CNC turning process is greatly influenced by depth of cut followed by cutting speed. It is observed that the feed is most significantly influences the Ra followed by nose radius. For simultaneous optimization of Surface roughness (Ra) and material removal rate (MRR) depth of cut is the most significant parameter affecting the performance followed by the nose radius. Ray Taheri conducted experiments to evaluate various properties of three types of EN coatings, namely, low, medium, and high phosphorus. They concluded that EN coatings have excellent adhesion properties. No sign of separation, branching, chip off, or delamination of the coatings was observed. In particular, high phosphorus EN coating shows better corrosion resistance (due to its nano-crystalline microstructure) whereas low phosphorus EN coating shows better wear resistance (due to its high hardness value). The results of erosion-corrosion experiments showed that EN coatings had excellent erosion-corrosion resistance at a high temperature, 100°C, in a potash brine environment. Niraj, Satnalika, Ankesh Khandelwal (2013) suggested that the hard turning operations to be performed in the inserts with a single layer of TiCN coating on the inserts. They coated it upto a layer of 15-18 microns. The coatings were applied over the cemented carbide. The cemented carbide is also known as the Tungsten carbide along with cobalt matrix. They obtained the result such that it had a semi continuous finish and obtained a hardness of 3000 Hv. M. Narasimha, R. Reiji Kumar (2009) considered TiN coated tool for turning the AISI 1018 steel under dry conditions. They conducted experiment over the CNC turning for uncoated and the coated tool. They concluded the uncoated tool experienced more flank wear and tool wear, coated tool produced 50% less wear compared to the uncoated tool, TiN coatings had more wear resistant than other coatings. Rajnik R Chadaniya, Harshad D Patel, Alpesh H Makwana studied the effect of cutting tool coating material and coating process found that the coating material and number of coating layer affects the tool flank wear during cutting. Increasing coating layer tool flank wear decreases. Feed rate increase tool life decrease and surface finish increase. PVD coating process was better for thin and multilayer coating process. During machining of SS304 Built up edge and poor surface finish produces during machining T. Cselle, O. Coddet, C. Galamand, P. Holubar, M. Jilek, J. Jilek, A. Luemkemann, M. Morstein studied PVD coating in detail and concluded that The new generation of PVD coatings TripleCoatings3® uses the advantages of conventional (TiN, CrN, TiAlN, AlTiN) and nanocomposite coatings (nc-TiAlN/a-SiN, nc-AlCrN/a-SiN, nc-AlTiCrN/a-SiN). TripleCoatings3 are applicable for general purposes but they achieve the best results in high-performance machining. The coating takes place in coating units using LARC®- and CERC®-Technology. The TripleCoatings3® were introduced in the spring of 2007 and are widely being used extensively in the manufacturing industry all over the world.

IV. CONCLUSIONS

The advantages of using nickel such as hardness, low coefficient of friction, magnetic properties, corrosion and wear resistance is realized from the above review papers. The advantages of using nano coating such as erosion and corrosion resistance and less flank wear is realized from the above review papers

The advantages of various geometric inserts is an evident to identify the insert which is suitable for machining operations involved in various mechanical properties such as surface roughness, machining time. The advantage of identifying the type of the chip makes us to ensure the surface finish of the workpiece machined. The advantage of comparing the various geometric inserts by the mechanical properties with the variation of machining parameters such as speed, feed and depth of cut is to realize the suitable insert for optimized mechanical properties needed in specific machining process.

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