A REVIEW OF PERFORMANCE OF COATED CARBIDE INSERTS UNDERVARYING CUTTING CONDITIONS

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***ABSTRACT** - The paper presents the information mainly on cutting tool material such as coated carbide inserts. Manufacturing costs can be reduced by increasing the performance of tool material. The purpose of developing a new cutting tool is to reduce lead time, reduction in the manufacturing cost and improves surface roughness and material removal rate. Carbides were introduced in 1930. These are the most important tool material because of their properties like Wear resistance.The paper shows the study of the performance of Coated Carbide Inserts undervarying cutting conditions like depth of cut and feed rate. The objective of this study is to analyze the effect of coated carbide inserts on the work material.The study reviews the literature on the Performance of Coated Carbide Inserts*.

Keywords : Coated carbide inserts / MRR / Machining / Taguchi's technique

INTRODUCTION

The purpose of developing a new cutting tool material has the following advantages like lead time reduces, the manufacturing cost has been reduced, difficult and hard materials are easily machined, improve surface roughness and material removal rates (MRR) increases. In several types of the machining process, the most important parameter which needs to control or reduce are cutting temperature and cutting force because these parameters directly affect the life of tool thus affected the tool cost. Metalworking fluids are essential coolants and lubricants used in material removal and deformation processes to upgrade manufacturing productivity by increasing process throughout and tool life. Conventional cutting fluids flop to transfuse the tool-chip interface and consequently fail to strip the heat generation in the cutting zone. A no. of researchers also reported the fact that machining costs are quite high due to the use of cutting fluids during the machining processes which have considerably of higher cost than that of the cutting tools used for the machining. Besides, the costs which are related to the cutting fluid supply and their dumping are not negligible when they are compared with the overall production costs. Experiments also show that use cryogenics as coolant tends to enhance the tool life significantly compared to the dry cutting. It is also found out that cryogenic machining lessens the surface roughness and the tensile residual stress of the machined surfaces.

Hard coating is an essential aspect of cutting tools material. These hard coatings are the thin films that can range from one layer to hundreds of layers and can have a thickness ranging from few nanometers to few millimeters. The objective of a hard coating is to the significant increase in the life of the cutting tool. The TiN coated tool life is increased by four times the tool life of a non-coated HSS tool.

Carbides were introduced in the 1930s. Because of their high hot hardness and wear resistance, these are the most important tool materials. The main disadvantage of cemented carbides is their low toughness. Powder Metallurgy process is used to produce these types of materials, sintering grains of tungsten carbide (WC) in cobalt(Co) matrix (it provides toughness). There must be other carbides in the mixture, such astantalum carbide (TaC) and/ortitaniumcarbide(TiC) in addition to WC.

LITERATURE SURVEY

Noordinet.al. discussed the performance evaluation of cemented carbide tools in turning AISI 1010 Steel. Three cemented carbide tools; two coated tungsten-based cemented carbide tools (one Al_2O_3 (black) outer layer, second TiN (golden layer)), and uncoated titanium-based cemented carbide (silver-grey layer). With Cutting forces and surface roughness measurements it was observed that the tool had the CVD with TiCN/TiC and PVD with TiN coating layer sequence performed best under conditions as lower forces with little variations, good surface finish, chips with minimum SSZ thickness were produced. The Surface finish was more with increasing cutting speed.Ming et al. studied the finish-turning of NiCr20TiAl nickel-based alloy by using Al_2O_3/TiN-coated carbide tools. They investigated the effect on cutting forces, surface integrity, and tool wear. They found that the cutting forces decreased slightly with an increase of the cutting speed and increased with feed and depth of cut and plastic flow of the machined surface was produced at low cutting speed. In view of surface quality and tool wear, they recommended the parameters as cutting speed of 60 m/min and feed of 0.15 mm/r was, and depth of cut not exceeding 0.4 mm. Krishankantet.al. applied the Taguchi Method for Optimizing Turning Process by the effects of Machining Parameters. EN24 as the work material has been used and designed the Taguchi orthogonal array, with three levels of turning parameters, with the help of software Minitab 15. Experiments were repeated twice and the material removal rate (MRR) was calculated and it has been predicted that the Taguchi method, as it reduces the number of experiments, is a good method for the optimization of various machining parameters. Optimum parameters (Spindle Speed, Feed Rate & Depth of Cut) for the machining of EN24 Steel for higher Material Removal Rate has been calculated.Deiabet.al. investigated the effect of turning of Titanium-6Al-4V alloy using the Uncoated Carbide Tool at a certain speed and feed. Rapeseed vegetable oil was used as a cutting lubricant and the Minimum Quantity Lubrication (MQL) technique was adopted. The main focus was on surface roughness, flank tool wear, and energy consumed during turning. The data was recorded after experimentation and analysis were done. It was found that vegetable oil was a more sustainable alternative as compared to synthetic oil in terms of tool flank wear, surface quality, and energy consumed during cutting, Especially at feed rate close to 0.1 mm/min and cutting speed 90 m/min for turning of Titanium Elmunafi.et al. investigated the effect on the tool life of the Wiper Coated Carbide cutting tool during turning of Hardened AISI 420 Stainless Steel. Castor oil was used as cutting fluid and Minimum Quantity Lubrication (MQL) was adopted to supply the fluid to the cutting zone. No. of experiments was performed by varying the cutting speed. After experimentation, the results revealed the tool life is inversely proportional to the cutting speed and feed rate both, but cutting speed had a more significant effect on tool life than the feed. And during the investigation, the optimal cutting parameters for coated carbide cutting tools were found to be 170m/min cutting speed and feed rate of 0.24 mm/rev.Qehaja N. et.al. investigated the effect of various cutting parameters on surface roughness in dry turning using Tungsten Carbide inserts. It has been found that feed rate, nose radius, and cutting time were the main influencing factors for surface CO2 cooling was completely residue-free due to the sublimation of the cryogenic media at a higher temperature. Also due to missing lubrication effect leads to adhesion on the workpiece surface, additional lubrication has to be implemented with CO2.

Paturi et al.had done the analysis and measurement of surface roughness during turning of Inconel 718 using Tungsten disulfide (WS2) solid lubricant assisted Minimum Quantity Lubrication (MQL). For the research work micron-sized WS2 solid lubricant powder particles were dispersed (0.5%) in emulsifier oil-based cutting fluid (20:1). The effect of cutting parameters on surface

roughness. Three-level factorial experiments were designed and carried out and the regression equation was generated. The results showed that the feed rate influenced the surface roughness (0.513) more significantly than the nose radius (0.394) and cutting time (0.258). The obtained results were more significant than the previous results in the research field.Talib N. et.al. evaluated the performance of chemically modified Crude Jatropha Oil (CJO) for the machining process as a bio-based metalworking fluid. Transesterification process was adopted to develop Modified Jatropha Oil (MJO) with different molar ratios of Jatropha Methyl Ester (JME) to Trimethylolpropane (TMP). Viscosity and density tests were conducted on MJOs and the samples were compared with CJO and synthetic ester (SE). Experiments were performed by supplying all the fluids one by one to the machining area. The results revealed that the lubricant viscosity had a significant effect on machining performance, as the viscosity of lubricant decreases the cutting temperature, and cutting forces were also increased. The results also showed that MJO recorded a better performance in terms of machining performance and lubricating properties and was able to substitute SE. Due to a lack of thermal stability and oxidation, CJO was not recommended to be used as a metalworking fluid.

Busch K. et al. investigated various strategies of cooling and lubrication for machining high-temperature alloys. Titanium Ti6Al4V and Inconel 718 was taken as working material for investigation. The objectives behind the research were to increase the tool life, surface quality, reduction in machining cost, processing time, and energy consumption. The three methods of cooling and lubrication adopted were High-Pressure Cooling (HPC), Aerosol dry lubrication with CO2, and cryogenic cooling by CO2. Experiments were performed and the results showed that HPC was beneficial in roughing operations as high material removal rates reduce the specific energy consumption and reasonable tool life was recorded. ADL with CO2, when supplied to cutting zone in very fine spray form reduces the friction thermal load on cutting edge and the process was almost dry, prevents the cleaning of workpieces and chips.

roughness was evaluated using the Taguchi design approach and ANOVA. Multiple linear regression equation was used to find a correlation between cutting parameters and surface roughness. Two lubrication strategies were used, one was WS2 dispersed in emulsifier and the other was oil-based emulsifier alone supplied to the cutting zone by MQL method. No. of experiments was carried out by varying the cutting parameters the results demonstrate that for both the machining environments the optimal cutting parameters for surface roughness of machined material were cutting speed at level 3 (100m/min), feed rate at level 1 (0.1mm/rev) and depth of cut at level 1 (0.05mm). The

Surface quality of machined work was also improved about an average of 35% when WS2 solid lubricant was used rather than emulsifier oil-based cutting fluid alone.

Ashutoshet. al. explored the consequent effect of cutting parameters on surface roughness by employing combined techniques such as orthogonal array and analysis of variance in turning of hardened AISI 4140 steel with PVD-TiN coated mixed Al2O3+TiCN ceramic inserts under dry environment. They found that surface roughness is principally affected by feed and the depth of cut has a minor effect. Whereas cutting speed has a negative effect on surface roughness value with an increase in cutting speed upto 170 m/min caused by restricting the BUE formation. The value of roughness increases further with an increase of cutting speed, which can be due to either the vibrations or material side flow related to high speeds.Punit et al. have used the Taguchi method for optimizing machining parameters using carbide insert for rough mild steel surfaces. They performed a turning operation based on the number of test runs to be conducted. After that as per the designed matrix of experiments, they have performed and analysis was done after experimentation. They found that the factors significantly affect the surface roughness during turning. They concluded that cutting speed is a significant parameter. Feed rate is a more significant parameter as compared to the depth of cut on the surface roughness during turning of mild steel.

Pathanet.al.had done the analysis and investigation of machining parameters in finish hard turning of AISI 4340 Steel. It figures out the effect of input parameters on surface roughness of hardened AISI 4340 steel material. They used Taguchi's technique as an experimentation method and a multiple regression method is used in order to optimize the machining parameter for minimum surface roughness.

It was found that the cutting speed and nose radius playsasignificant role in the experimentation to achieve the lowest surface roughness. Simultaneously the feed and depth of cut have played the least role in the experimentation to achieve desirable surface roughness. Amlana et al. have Investigated Flank Wear in Hard Turning of AISI 52100 Grade Steel Using Multilayer Coated Carbide and Mixed Ceramic Inserts.Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS) approach has been utilized to compare the results of both tools. The tests were conducted on 40 mm diameter and 120 mm long AISI 52100 steel, with a hardness of 55±1 HRC. It was observed that hard turning of AISI 52100 bearing steel with aluminium oxide multilayer coated carbide insert is regarded as steady and stable machining without any premature tool failure as weightage of Aluminium remains almost the same. No ultimate failure like, tip breakage or catastrophic collapse, plastic deformation on the cutting tip has occurred. Denis et al. analyze the tool wear rate in function of the cutting speed in the hard turning of the steel AISI 52100 with a hardness of 50 HRC for three different types of cutting tool materials. They used the focus variation microscope to access the tool wear. The tool wearrate is calculated based on ordinary least squares adopting five values of WRM in five machining time intervals. It was found that experiments were performed at different cutting speeds. At vc = 120 m/min, the PCBN presented the lowest tool wear rate, at vc = 150 m/min, the coated cemented carbide (tool wear rate on the coating) had the best performance (417 μm3/s). The mixed ceramic tool shows a well performance at the higher cutting speeds of vc = 187.5

CONCLUSION:

In the present study,the performance of coated carbide inserts under varying cutting conditions has been reviewed. The machining of the hard materials at higher speed is improved by using the Coated tool .From the Investigation, It is observed that tool life is inversely proportional to the cutting speed and feed rate both , but cutting speed had a more significant effect on tool life than the feed. When we use CVD with TICN/TiCAnd PVD WithTiN Coating layer sequence performed best under conditions with lower force with little variation and good surface finish. Some results also revealed that lubricant viscosity had a major effect on machining performance, as the viscosity of lubricant decreases, the cutting temp. And cutting force wasIncreased.

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