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A Review on Parametric Analysis and multi objective optimization of process parameters of turning of AISI (4140)with PVD & CVD cutting tool

KEYWORDS: Turning, Ra, MRR, full factorial

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ABSTRACT Modern manufacturers, seeking to remain compétitive in the market, Relay on their Manufacturing engineers and production quality. This Paper présent multi response optimisation of turning parameters for Turning on AISI 4140 Alloy Steel with both PVD & CVD coated tool. For that purpose take cutting speed, depth of cut & feed rate as a input parameter and measure the surface roughness & material removal rate. Full factoriel method will be use For experiment design. The Analysis of Variance (ANOVA) is employed to analyze the influence of Process Parametres during Turning.

I. INTRODUCTION

Computer Numerical Control (CNC) is one in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric data. Under CNC Machining, machine tools function through numerical control. A computer program is customized for an object and the machines are programmed with CNC machining language (called G-code) that essentially controls all features like feed rate, coordination, location and speeds. With CNC machining, the computer can control exact positioning and velocity. The machines follows predetermine sequence of machining operation at predetermine speeds necessary to produce work piece right shape and size. A different product can be produced through reprogramming and low quantity of production run of different product justified.

Turning is the machining process in which material remove from work piece by moving the cutting tool in the direction of axis of rotation. Turning can be done on the external surface of the part as well as internally (boring).Turning can reduce the diameter of work piece as per required extent and produce smooth surface. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape. Turning is used to produce rotational, typically axis-symmetric, parts that have many features, such as holes, grooves, threads, tapers surface.

Fig.1 shows the turning operation.

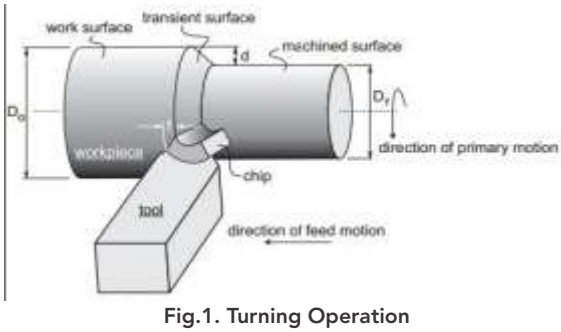

Fig.1. Turning Operation

Cutting speed in turning V in m/s is related to the rotational speed of the work piece by the equation;

$$V = \pi DN$$

Where D is the diameter of the work piece; N is the rotational speed of the work piece. The three primary factors in any basic turning operation are speed, feed, and depth of cut.

In our project we are going to use AISI 4140 steel. The chemical composition of AISI 4140 steel is given in below

Table 1.
Table 1.Chemical Composition

Iron, Fe	96.78-97.77%
Chromium	0.80 - 1.10%
Manganese	0.75 - 1.0%
Carbon	0.380 - 0.430% 12.00%
Silicon	0.15 - 0.30%
Molybdenum	0.15 - 0.25%
Sulfur	0.040%
Phosphorous	0.035

AISI 4140 is used in Adapters, Arbors, Axle Shafts, Bolts, Crankshafts, Connection Rods, and Chuck Bodies.

2. LITERATURE REVIEW

Mummer nalbant, Hasan gokkaya & ihsan toktasa, et al, [1] were carried out "The experimental investigation of the effect of uncoated, PVD and CVD coated cemented carbide insert and cutting parameters on surface roughness in CNC turning and its prediction using artificial neural networks" in this study machining of AISI 1030 steel by uncoated, PVD and CVD coated cemented carbide insert with different feed rate (0.25,0.30,0.35,0.40,0.45 mm/rev) with cutting speed of (100,200 and 300 m/min) by keeping depth of cuts constant (2mm). The surface roughness effect of coating method, coating material at different cutting speed and feed rate on the work piece has been investigated by them. For that purpose they use (ANN) artificial neural network which

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predict the surface roughness value. The result reveals that experimental value and ANN prediction are compared by stastical error analyzing method. It is shown that SCG model with nine neurons in the hidden layer has produced absolute fraction of variance (R^2) values about 0.99985 for training data and 0.99983for test data so, in this experiment root mean square error smaller than (0.00265) and mean error percentage (1.13458) and (1.88698) for training test data so, surface roughness value has been find out by ANN with an acceptable accuracy.

Ashok Kumar sahoo, kashfull orra and b.c.routra, et al, [2] were carried out "Application of response surface methodology on investigating flank wear in machining hardened steel using PVD TiN coated mixed ceramic insert" in this study, they carried out turning of hardened EN 24 steel with PVD TiN coated ceramic insert under dry environment and investigate the effect of process parameter on flank wear (VB). Investigator developed mathematical model in terms of cutting speed(v) feed rate (f) and machining time (t) as a input variable using response surface methodology and experiment conducting with three level of full factorial design technique. The adequacy model has been checked using co-relation co-efficient. As the determination co-efficient, R^2 (98%) is higher for model developed better response model finds actual data. The result revels that predicted flank wear has been found to lie close to the experimental value and also machining time has been found that most significant parameter on flank wear by ANOVA studies.

A.I. Fernández-Abia1, J. Barreiro1, J. Fernández-Larrinoa, et al, [3] were carried out "Behavior of PVD coatings in the turning of austenitic stainless steels" In this context, PVD process is optimum for obtaining sharp edges. Therefore, a methodology is presented to evaluate the performance of PVD advanced tools for turning of difficult to machine materials. Four coatings were tested: AlTiSiN (nACo), AlCrSiN (nACRo), AlTiN and TiAlCrN. The analysis was developed carrying out wear tests and analyzing different signals such as cutting forces, EDX analysis of inserts, part roughness and insert image analysis. Results indicate that the best coatings for turning of difficult to machine materials as austenitic stainless steels are nACo and AlTiN coatings, since they offer the best performance. Several factors demonstrate it: better tool flank wear evolution, less tangential cutting force or lower part roughness.

M.kaladhara, k.venkata subbainahb & Ch.Shrinivasa raob, et al, [4] were carried out " parametric optimization during machining of AISI 304 austenitic stainless steel using CVD coated DURATO-MICTIM cutting insert" in this study investigator carried out turning on AISI 304 austenitic stainless steel by CVD coated cemented carbide cutting insert which is produced by duratomic technology. They conducted test at four level of cutting speed, feed and depth of cut. The influence of this parameter is investigated on the surface roughness and material removal rate. The analysis of variance also used for the analyze the influence of cutting parameter during machining. From the whole procedure they concluded that cutting speed significantly (46.05%) affected the machine surface roughness value. The influence of depth of cut (61.03%) in affecting MRR is significantly large.

H.K.Dave, L.s.patel and H.k.raval, et al, [5] were carried out " effect of machining conditions on MRR and surface roughness during CNC turning of different material using TiN coated cutting tools- a taguchi approach" in this study, the investigator carried out turning on EN-8 & EN-31 material with CNMG 120408 (PVD coated) tools. The quality surface finish is an important requirement for many turned work piece so the investigator focused on analysis of optimum cutting condition to get lowest surface roughness and maximum material removal rate by taguchi technique. The orthogonal array, signal to noise ratio and analysis of variance were employed by them to study performance characteristic in dry turning operation. At the end result revealed that, ANOVA has shown that the depth of cut has significant role to play in producing higher MRR and insert has role to play for producing lower surface roughness so reduces the production cost in an automated manufacturing environment.

R.Suresh, S.basavarajappa,G.l.samual, et al, [6] were carried out "Some studies on hard turning of AISI 4340 steel using multilayer coated carbide tool" in this study, investigator carried out turning on AISI 4340 steel using Multilayer coating (TiC/TiCN/Al2O3) on cemented carbide substrate (CVD process) for that purpose, they take Cutting speed(140,200,260 m/min), Feed rate (0.10,0.18,0.26), Depth of cut (0.60,0.80,1.0) as a input parameter and measure the Machining force, specific cutting force, power, tool wear, surfaces roughness. An attempt has been made to analyze the effect of process parameter machinability aspect using taguchi technique. Response surface plot are generated for the study of interaction effect of cutting condition on machinability factor. The correlation was established by multiple linear regression models. The linear regression models were validated using conformation tests. The analysis of result revealed that optimal combination of low feed rate and low depth of cut with high cutting speed is beneficial for reducing machining force. Higher value of feed rates is necessary to minimize the cutting force. The machining power and cutting tool wear increase almost linearly with increase in cutting speed and feed rates. The combination of low feed rates and high cutting speed is necessary for minimizing the surface roughness.

Swapnagandha.S.Wagh, Atul.P.Kulkarni, Vikas.G.Sargade, et al, [7] were carried out "Machinability studies of austenitic stainless steel (AISI 304) using PVD cathodic arc evaporation (CAE) system deposited AlCrN/ TiAlN coated carbide inserts." The focus of the paper is on green machining, the environmentally friendly manufacturing (dry machining) which is ecologically desirable and cost effective. The "Cathodic Arc Evaporation Technique (CAE)" is used for depositing AlCrN/ TiAlN coating used for dry, high speed turning of AISI 304 austenitic stainless steel the effect of machining parameters on the cutting force, cutting temperature and surface finish were investigated during the experimentation. It is found that, as feed increases, the radial force increases therefore more friction exists between newly generated surface and the flank face so surface roughness increases. Tool-chip interface temperature increases with increase in cutting speed and it is higher because of low thermal conductivity of the coating as well as AISI 304 work material and AlCrN/TiAlN coating. Thermal stability of the AlCrN/TiAlN coating is good therefore it withstands the high temperature and gives better performance especially in case of dry turning and it also helps in reduction in cutting forces. The present approach and results will be helpful for understanding the machinability of AISI 304 steel during dry, high speed turning for the manufacturing engineers.

M.Y.Noordin, v.c.venkatesh, c.l.chan, a.abdullah, et al, [8] were carried out "Performance evaluation of cemented carbide tools in turning AISI 1010 steel." In this paper, the performance of three cemented carbide cutting tools, two coated tungsten based cemented carbide one with Al2O3

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(black) outer layer the other with TiN (golden), uncoated titanium based (silver grey) cemented carbide tool, with 80˚-diamond insert shape were investigated during finish turning of AISI 1010 steel. The PCBNR tool holder, giving side cutting edge angle of +15˚, was used. Cutting test were performed with constant depth of cut and at various cutting speeds and feed rates to investigate the performance of the tool under dry cutting conditions. Cutting force and surface roughness were measured. The chip produced by the maximum crystal elongation. The tool which had the CVD with TiCN/TiC and PVD with TiN coating layer sequence performs best under the condition tasted, as lower force with little variation were encountered, very good surface finish could be obtain with minimum thickness, that contributed to low chip strain and therefore to low residual stresses on the work piece surface.

Ibrahim ciftci, et al, [9] were carried out "Machining of austenitic stainless steels using CVD multi-layer coated cemented carbide tools" this paper present the experimental work in dry turning of austenitic stainless steels (AISI 304 and AISI 316) using CVD multi-layer coated cemented carbide tools. The turning test conducted at four different cutting speeds (120,150,180 and 210 m/min) while feed rate and depth of cut were kept constant at 0.16 mm/rev and 1mm respectively. The cutting tools used were TiC/TiCN/TiN and TiCN/TiC/Al2O3 coated cemented carbides. The influence of cutting speed, cutting tool coating top layer and work piece material were investigated on the machine surface roughness and cutting forces. The worn parts of the cutting tool were also examined under SEM. The result showed that cutting speed significantly affected the machine surface roughness values. With increase cutting speed, the surface roughness values decreased until the minimum value is reached beyond which they increased.

Conclusion

A From the above literature survey we find that there are many research done on optimization techniques for process parameter for surface roughness and material removal rate. But we found that there are very few research done on AISI 4140 with PVD & CVD both cutting tool so we want to do research on this material with the help of both coated tool. We like to use full factorial method and ANOVA for percentage contribution.

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