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Review on Optimization Process Parameters of HCHCR, OHNS, EN24 Materials

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Abstract: ***Cubic boron nitride (CBN) is the second hardest material in the material. Diamond is the only hardest material & its natural material. CBN is actually a powder which is coated on the caeamics/ carbide inserts, in that the binder materials are titanium, so the there is huge area to work on the tool life of CBN inserts, because it is costlier than tungsten carbide & other insert materials. The hard-turning process is steadily finding its place in modern manufacturing technology and with advance cutting tool materials it can be applied as another machining process to turning providing a more economical way to finish hard surfaces. The main concerns of hard turning are tooling cost and the effect of process on machining characteristics. The poor selection of this parameters may cause excessive tool wear and increased surface roughness. Hence there is a need to find the right parameters to achieve the right dimensional accuracy, good surface and maximum material removal rate. This paper reviews the effects of various process parameters such as cutting speed, depth of cut and feed rate on the response parameters such as surface roughness, material removal rate and chip reduction coefficient. Through this study main cutting parameters which affect the turning operation are discussed.***

Keywords: CBN, HCHCR CUTTING SPEED, FEED, DEPTH OF CUT

1. Introduction

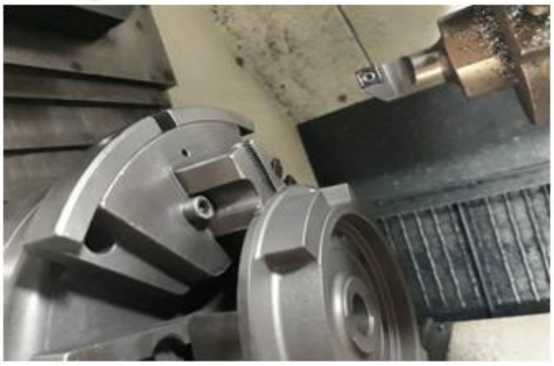
Cubic boron nitride

Here the cbn tool insert is used to do the machining on hchcr & ohns mtrl to find the number of useful grades to use. Industries are not interested to take the trial of new grades .i.e. CNMA & CNMG on HCHCR & OHNS materials. many papers shows the optimization of product of ohns & got the better tool life of carbide tools, nobody could not do the test by CBN insert tool. By taking no. of reading, we will get the optimum process parameters for a specific materials & tool. Then after the practical experimentation 3 to 4 times, we will go through the MINITAB17<START<TAGUCHI<CREATE TAGUCHI DESIGN< Then following some steps we will get the optimum parameters by comaring with actual readings. Cubic boron nitride (CBN or c-BN) is widely used as an abrasive. Its usefulness arises from its insolubility in iron, nickel, related alloys at high temperatures, whereas diamond is soluble in these metals to give Carbides carbides. Polycrystalline c-BN (PCBN) abrasives are therefore used for machining steel, whereas diamond abrasives are preferred for aluminum alloys, ceramics, and stone. When in contact with oxygen at high temperatures, CBN forms a passivation layer of boron oxide. Boron nitride binds well with metals, due to formation of interlayers of metal borides or nitrides. Materials with cubic boron nitride crystals are often used in the tool bits of cutting tools. For grinding applications, softer binders, e.g. resin, porous ceramics, and soft metals, are used. Ceramic binders can be used as well. Commercial products are known under names "Borazon" (by Diamond Innovations), and "Elbor" or "Cubonite" (by Russian vendors). Similar to diamond, the combination in c-BN of highest thermal conductivity and electrical resistivity is ideal for heat spreaders. Contrary to diamond, large c-BN pellets can be produced in a simple process (called sintering) of annealing c-BN powders in nitrogen flow at temperatures slightly below the BN decomposition temperature.

CBN is used in industries is just to remove the grinding operation, its cost, its failure, all the expenditure will be eliminated by using cbn inserts with better accuracy.

The machining is done after the heat treatment of material.

This ability of c-BN and h-BN powders to fuse allows cheap production of large BN parts. In modern machining industries, the main challenge emerging is the achievement of high quality, in terms of work part dimensional accuracy and surface finish, high production rate and cost saving. Traditionally hardened steels have been machined by grinding process, on the other hand grinding process is time consuming and it applicable to limited range of geometries. Hard turning is basically a turning process suitable for machining parts with hardness exceeding 45 HRc which provides similar surface finish and dimensional accuracy to those achieved in grinding.



Hard Turning

Hard turning process is defined as machining of metals with hardness greater than 45 HRc. In Hard turning process a single point cutting tool is used either linearly in the direction parallel or perpendicular to the axis of rotation of the workpiece or along a specified path to produce complex rotational shapes. The main advantage of hard turning is that turning operation is carried out on same machine on which soft turning is done before so there is less setup time is required in finish turning. A proper hard turning process gives surface roughness ranging between 0.4-1.0 micro meters. The starting point of hard turning is the material hardness 47 HRC but regularly hard turning is done on the material having hardness 60HRC and higher. The materials required for hard turning are tool steel, case-hardened steel, bearing steel, Inconel, Haste alloy and other exotic materials are also falling in the category of hard turning. Hard turning is a technology-driven process and therefore depends on machine and work holding technology. Hard turning requires special tool materials, with high wear-resistant and high hardness at elevated temperatures. The most commonly used as tool materials are: silicon nitrides, sintered carbides, cermets, polycrystalline diamonds, oxide and mixed ceramic, cubic boron nitrides (CBN). Polycrystalline cubic boron nitride is characterized by extraordinary hardness at elevated temperatures and compressive strength with good fracture toughness. Hard turning fits perfectly in machining plants with the latest trends for increasing production flexibility. Ideal candidates for hard turning are complex parts where direction, contour, or multiple diameters require form grinding wheels and number of setups for complete grinding of all surfaces. Hardened steel bearings, gears and axle shafts are already being machined using hard turning. Hard turning has already replaced rough grinding operations of bearing races. Nonfunctional zones such as ODs and side faces are quite often hard finish turned. On a daily basis, parts are being hard turned in the following industry segments: automotive, bearing, marine, punch and die, mould, hydraulics and pneumatics, machine tool and aerospace. The traditional method of machining the hardened steels includes Rough turning, heat treatment. Recently hard machining emerges as an attractive alternative to conventional turning due to its potential benefits such as short cycle time, process flexibility, higher material removal rate, good surface finish and less environmental problems as there is negligible use of cutting fluid. Hard turning has several advantages over grinding and some of them are: The ability to produce complex geometry in one set up;

2. Important Parameters In Hard Turning

2.1 Process Parameters

There are basically three main cutting parameters in turning operation which are feed rate, speed and depth of cut. Although there are other factors which are important to a turning process such as material type, hardness, dimension and type of tool being used, but the main three parameters are the ones one can change to improve the process.

2.2 Cutting Speed

Cutting speed is defined as the speed at which the work moves with respect to the tool. It is usually measured in metres per minute (m/min). Cutting speed changes with change in work piece diameter even through the spindle speed remains the same. Cutting speed must be chosen wisely as if the cutting speed is too low then tool wears out quickly and if value is high then certain vibrations may occur.

$v = \frac{\pi D n}{1000}$ m/min

Here, v is the cutting speed

D is the initial diameters of workpiece in millimetre (mm) and N is the spindle speed in revolution per minute (RPM)

2.3 Feed rate

Is defined as the distance the tool travels one revolution of the part turned. It is expressed in distance per revolution (mm/rev). The selection of feed rate is the decision which affects the whole process. Tool feed rate greatly impacts the surface roughness of workpiece. The low feed rate gives good surface finish but results in low process speed and high feed rates means rapid wear of cutting tool.

2.4 Depth of cut

Depth of cut can be defined as the amount of material being removed from the material surface in a single pass. It is expressed in millimeters (mm). Depth of cut varies inversely to cutting speed and high depth of cut results in vibrations, chattering and high tool wear.

Chemical Composition of EN 24

Carbon 0.36-0.44%

- Silicon 0.10-0.35%
- Manganese 0.45-0.70%
- Sulphur 0.040 Max
- Phosphorus 0.035 Max
- Chromium 1.00-1.40%
- Molybdenum 0.20-0.35%
- Nickel 1.30-1.70%

Physical Properties of OHNS

Max Hardness	60-64
Heat Resistance	Low
Wear Resistance	Medium
Machinability	Good
Deformation During Hardening	Medium
Hardening Temperature	760-870
Resistance To Decarburization	Good
Density	7.85 g/cc

Chemical Composition of HCHCR

ELEMENTS	% COMPOSITION
C	2.00-2.35
Mn	0.60
Si	0.60
Cr	11.00-12.50
Ni	0.30
W	1.00
Cu	0.25
S	0.03
Fe	Remaining

In modern manufacturing industry surface finish emerges as most important quality characteristics which influences the performance of manufacturing process and manufactured products. Surface roughness is imperfections on the surface of materials in form of succession of hills and valleys varying both in height and spacing. The surface finish has direct contact with the functioning of machine parts, load carrying capacity, tool life, and fatigue life, bearing corrosion and wearing qualities. Failure due to fatigue always occurs at sharp corners because of stress concentration at that place. Different requirements demand different types of surface so measurement of surface texture quantitatively is essential. Surface irregularities can be classified into four categories gives as follows: -

1) First order- This type of irregularities is arising due to inaccuracies in the machine tool itself and the irregularities produced due to deformation of work under the action of cutting forces and the weight of the material.

3. Methodology

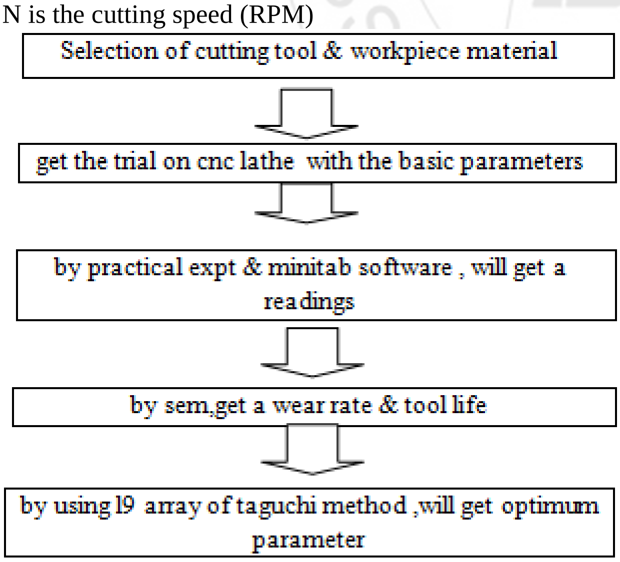
Material removal rate (MRR) is defined as the material is removed per unit time. In modern manufacturing industries turning is most common method used to metal cutting because of its ability to remove materials at faster rate with good surface quality. Material removal rate has great significance in metal removal process and is influenced by feed rate and depth of cut. The careful selection of cutting parameters improves the material removal rate which improves the overall productivity of manufacturing process. The material removal rate is calculated by using the equation given below

$Q = \pi$ Davg D F N

Where, Q is the material removal rate (mm^3/min)

F is the feed rate (mm/rev)

N is the cutting speed (RPM)



4. Conclusions

In this work, an attempt was made to determine the important machining parameters for performance measures like metal removal rate and surface roughness in the CNC Lathe machining process. Factors like spindle speed, feed rate, depth of cut found to play a significant role on parameters like metal removal rate and surface roughness. Through experimentation it is found that Feed Rate plays major role. Taguchi's experimental design method is Used To obtain optimum parameter combination for minimization of Surface roughness. Interestingly, the optimal levels of the factors for all the objectives differ widely. Analysis of variance was performed to study influences of the CNC Lathe machining variables. ANOVA results are used to find the effect significant factor on metal removal rate and surface roughness. On HcHcr-D3and OHNS,HDS H13 material in CNC turning. Based on the results obtained, the following conclusions The effects of the process parameters such as cutting speed, feed, depth of cut, on response characteristics viz. material removal rate, surface roughness, will see. can be drawn:

For MRR

1) Feed rate is the most significant factor for MRR for both the materials.
2) MRR is proportional to process parameter for both the materials.
3) 3.Third level of each parameter provides maximum MRR for both the materials.

For Surface Roughness

1) Feed rate is the most significant factor for Surface Roughness for both the materials.
2) Surface Roughness is proportional to the feed rate only.
3) In case of HCHCR spindle speed does not effect on surface roughness while in case of EN8 depth of cut does not affect on surface roughness. From this study It is concluded that for harden material spindle speed does not affect on surface roughness while for softer material depth of cut does not affect on surface roughness. Hardness does not affect on MRR.

5. Literature Review on Hard Turning

1) E.D Derakhshan et al. [2009] investigated the surface roughness of AISI 4140 steel by hard turning using two different grades CBN inserts. Five different work pieces with five different hardness level in the range of 45-65 HRc used. Process parameters of feed rate, depth of cut Cutting speed and hardness level were analyzed to find out that minimum surface roughness of (Ra=0.207) was obtained through machining 50 HRc cutting speed of 473 m/min [1].
2) H.Singh et al. [2011] investigated the effect of various cutting parameters on the material removal rate and surface roughness of EN-8 general purpose steel. Taguchi L16 orthogonal array is used to design the experiment and ANOVA was used to analyse the results. They found out that spindle speed and feed rate were the most significant parameters that provide significant amounts of Material removal rate and surface finish [2].
3) Samir Khamel et al. [2012] investigated the effects of process parameters like cutting speed, feed rate and depth of cut on tool life, surface roughness and cutting forces in hard turning of AISI 52100 of bearing steel of hardness 60 HRc with CBN tools. Taguchi L27 orthogonal array is

used for design of experiment and Analysis of variance (ANOVA) provides that cutting speed has 59.14% effect on reduction of tool life; surface roughness is affected by feed rate at 64.09%.
Optimized parameters are cutting speed Vc=168 m/min, feed rate=0.08 mm/rev, depth of cut=0.22 mm[3].

4) H.Aouici et al. [2012] investigated the effects of cutting parameters, workpiece hardness on surface roughness and cutting force components in hard turning of AISI H11 steel with CBN 7020 tool. Three different hardness levels of 40, 45, 50 HRc were selected as input parameters. By applying response surface methodology (RSM) and ANOVA they found out that feed force (Fa) and cutting force (Fv) are strongly influenced by depth of cut at 56.77% and 31.50% respectively and cutting speed has a little influence of 0.14 [4].

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