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EFFECTS OF TOOL SETTING ON TOOL CUTTING ANGLE ON TURNING OPERATION

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ABSTRACT

Accuracy of machined component is one of the most critical considerations for any manufacturer. Many key factors like cutting tool and its setting angle, machining conditions, resolution of the machine tool and the type of work place etc., play an important role. However, once these are decided upon, the consistent performance of the machine tool depends upon its ability to accurately position the tool tip vis-à-vis the required work piece dimension. Hence in this study the effect on Tool setting on cutting angle has been mathematically demonstrated. Lastly solution has been given that "Why we align the centre and "for what height, deviation of tool when set, then what change in tool angle should be done so as to get the result in such a way that there will be no effect on tool and work piece and we can get the greater accuracy of job in turning operation.

Keywords: tool geometry, chip-forming, chip-breaking, accuracy.

INTRODUCTION

Cutting tool angle plays a vital role in surface finish and also to get most desirable finish. We should match the centre of work piece with respect to Tool to make concentric. As far as matching of centre concerned, we should have correct data/datum that for what variation, the centre alignment shall be done. Hence how much tool angles should change as per defined in idle condition that also to be considered. Tool wear in hard turning not only modifies the cutting edge geometry but also increase cutting force and cutting temperature significantly, which, in turn, influence the residual stress profile in the machine surface. Therefore, wears in cutting edge is crucial during hard turning and temperature is one of the major factor which influences flank wear.

REVIEW OF LITERATURE

The wear mechanism of tin coated carbide and uncoated cerements tools were investigated at various combination of cutting speed, feed rate, and depth of cut for end milling of hardened AISI H13 tool steel. Hence at low speed, feed rate and depth of cut, SEM (scanning electron microscope) investigation has shown that both inserts experience uniform and gradual ware on the flank face, and diffusion and oxidation have also been observed [1]. Performance of P10 Tin coated carbide tool when end milling AISI H13 tool steel at high cutting speed, feed rate, and depth of cut on the tool life ware studied experimentally. Hence the result shows that the tool life is highly affected by the feed rate and depth of cut [2]. Effect of cutting speed on tool performance in milling of B4Cp reinforced aluminum metal matrix composites was investigated with the help of five different cutting speed at constant feed rate of 0.26 mm/Z were used in order to determine the effect of cutting speed on tool wear and tool wear mechanism [3]. Comparison between constant force and constant rate of feed in material graphic cut-off machines, surface quality in relation to cutting speed, force and rate of feed has been studied where this study shows that when cutting work piece of varying shape, the most uniform surface is obtained by using a constant rate of feed and this combined with high cutting speed will produce surface with the least and most uniformed information [3]. The influence of few rate and cutting speed on the cutting forces, surface rough ness and tool chip constant length during face milling has been studied where in the study, three component of the cutting forces developed during face milling AISI 1020 and AISI 1040 steel work piece were measured [4]. The effect of cutting speed and cutting tool geometry on machinability properties of nickel base inconel 718 as per alloy has been investigated. Hence machined with dry cutting condition by using digital controlled computer lathe with ceramic cutting tool in two different geometries and three different material qualities [5] Some effect of cutting edge preparation and geometric modifications when turning INCONEL 718^{TM} at high cutting speeds where this paper evaluates the performance of some inserts subjected to modifications on the edge geometric form and preparation, when turning, at high cutting speed, on a nickel base alloy, INCONEL 718^{TM}, hardened by solution and precipitation (44HRc) [6]. Influence of the critical cutting speed on the surface finish of turned steel base have been studies where variable such as feed rate and the tools of nose radius and cutting speed can provide a control on the quality and the surface finish in a given machining process [7]. Effect of federate, work piece hardness and cutting edge on sub surface residual stress in the hard turning of bearing steel using chamfer hone cutting edge geometry has been projected through numerical analysis that hone edge puts chamfer cutting edge and aggressive feed rate help to increase both Compressive residual stress and penetration depth [8]. Effect of cutting speed on the performance of Al2O3 based ceramic was the worst performing tool with respect to tool wear and the best with respect to surface finish. Tin coated Al_2O_3 + TiCN mixed ceramic tool is the most suitable one for turning modular cast iron, especially at high cutting speed [9]. An experimental study of the

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effect of cutting speed on chip breaking study concluded that due to the effect of cutting speed on minimum feed for chip-breaking, when machining a continuous chip-forming material, chip-breaker with a wide application range should be selected [10]. The effect of proper tool setting on tool cutting angle with respect to work piece, provides greater accuracy of work [11]

In the literature survey it has been observed that no work been carried out related align the centre of work piece with respect to tool and what variation in centre alignment, how much tool angles should change as per defined in idle condition (Concentric). Hence a mathematical demonstration has been shown for the same to obtain most desirable finish.

MACHINE SPECIFICATION

Machine Name
MAZAK QUICK TURN 15 N, 3 AC - 415V, 50/60HZ

Size (Height): 1810 mm
Floor Space Required (Width x Length): [2360 x 2570] mm
Machine weight: 4400 kg
Shape of bed: Horizontal
Bed width: 340 mm
Positioning Accuracy: 0.008 mm[X - axis]
0.013 mm [Z - axis]
Reparative Positioning Accuracy: ± 0.002 mm [X - axis]
± 0.003 mm [Z - Axis]
Cutting Speed (CS) is measure in surface meter/minute = (Diameter in mm * π) * RPM / 1000; cutting speed required for Lathe operations without using a cutting fluid.

Cutting speed and feed is influenced by

- Cutting tool material
- Work piece material
- Tool Geometry.
- Use of chip breaker
- Desired tool life
- Cutting fluid used
- Type of the cut (Rough/Finish)
- Rigidity of m/c and tool with respect to work.

Turning and boring operation parameters

Material to be machining		Roughing	Finishing	Screw-thread cutting
Low-carbon steel 0.05 to 0.30% C	m/min	27	30	10-12
High-carbon steel 0.06 to 1.7% C	m/min	15	21	6-8
Brass	m/min	45	91	15-18
Aluminum	m/min	60	105	15-21

Tool angle for high-speed steel tool and various materials

Material	Side clearance angle, degrees	Side clearance angle, degrees	Back rack angle, degrees	Front clearness angle, degrees
Steel 1020	12	14	16	8
Medium steel 1035	10	14	16	8
Medium C. steel 1090	10	12	8	8
Screw steel X I 112	12	22	16	8
Cost iron	10	12	5	8
Aluminum	12	15	35	8
Brass	10	0	0	8
Monal metal	15	14	8	12
Plastic	12	0	0	8
Fiber	15	0	0	12

Carbide Tool require slightly greater cutting angle those shown in the above Figure because of the brittleness of the material. Side-Cutting-Edge angle of 5 to 20 degrees are recommended for those cutters.

As we know that cutting tool angle plays a vital role in surface finish and also to get most desirable finish. We should match the centre of Work Piece and tool i.e. to make concentric. As far as matching of centre is concerned, we should have data / datum that for "what variation", in centre alignment, how much tool angles should change as per defined in idle condition (concentric).

A mathematical demonstration is being shown here, that is why we align the centre and also to keep the centre at certain height what change in angles should be

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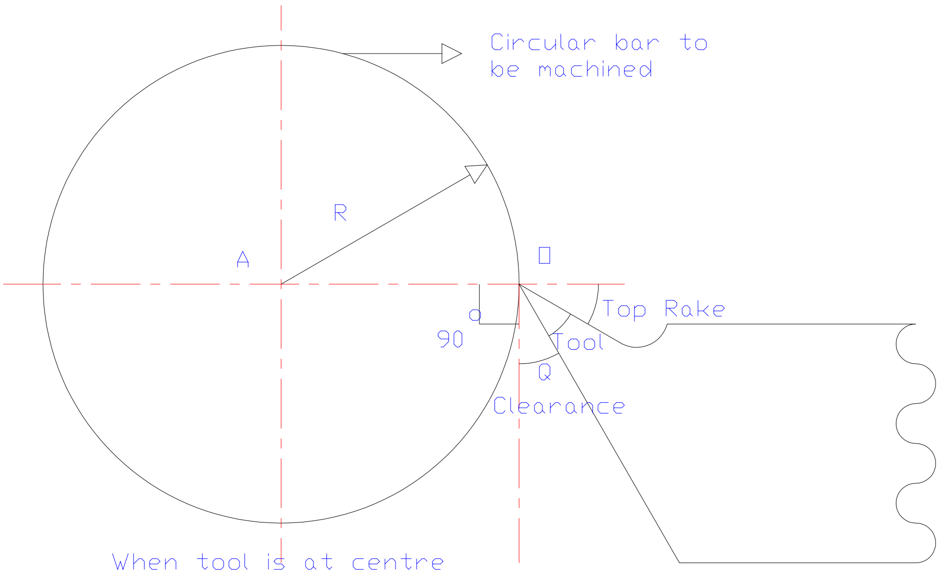
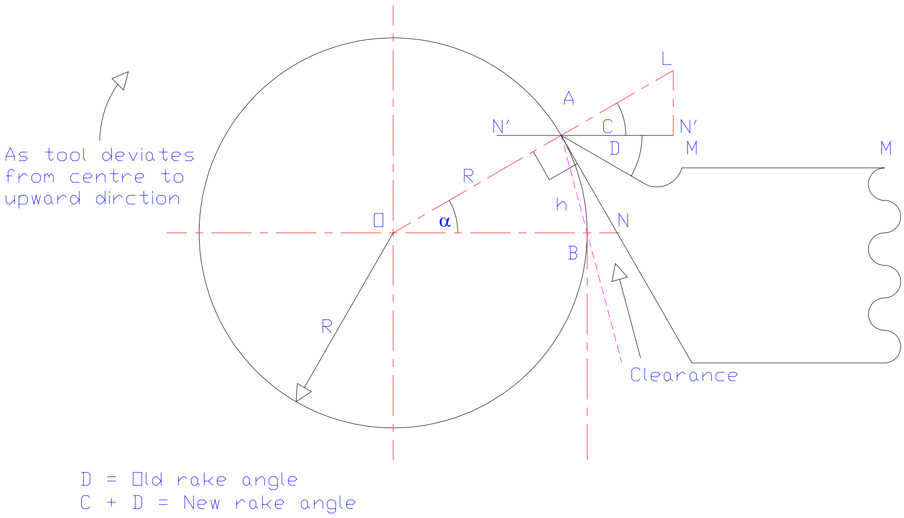
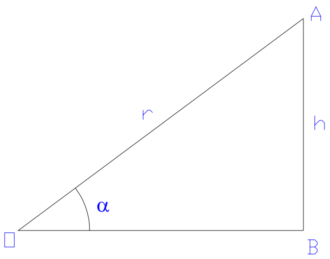
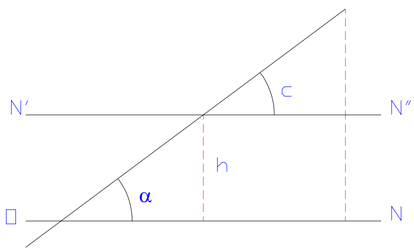
done, so that we will get same result (approximately). [But cutting force is different.]









Let h = height of deviation from centre
a = angle of deviation
Then from Δ OAB, we get,
Sin $\alpha = h / r$
$\therefore \alpha = \sin^{-1} (h / r)$
It is obvious that change in clearance = previous clearance – α [given, $\alpha = \sin^{-1} (h / r)$]
and new rake= previous rake + $\sin^{-1} (h / r)$

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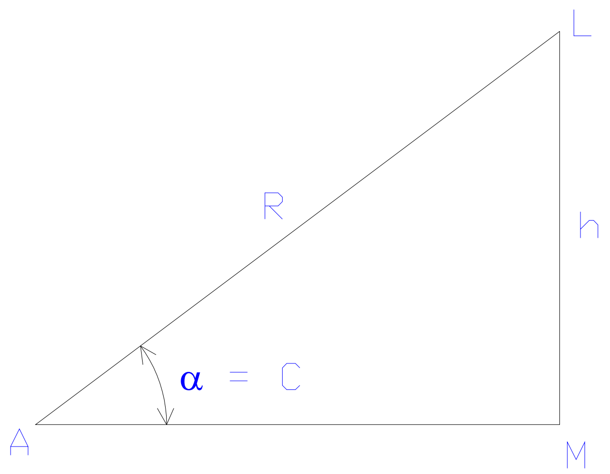


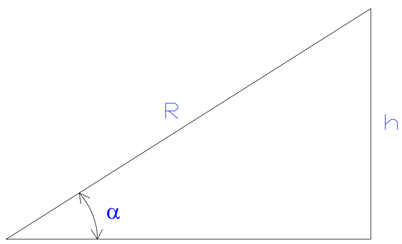
So, Sin α = h / R

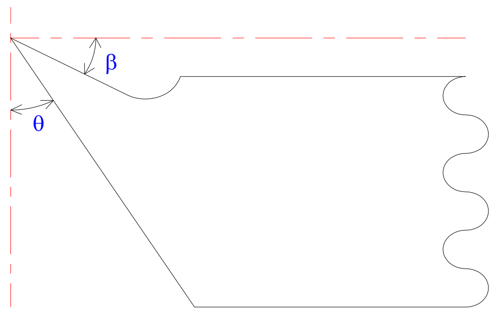
Here we are seeing that clearance angle is decreasing by α amount as rake, increasing by same amount. Here tool is being set at certain height (h) from the centre of the Work Piece. So after composing work-piece and tool with respect to new top rake angle will be equal to previous top rake plus amount of angle formed at the centre of work-piece, when tool is being deviated towards top direction. But clearance angle will be decreasing by the same amount as top rake increasing because clearance angle is always measured at the tangent, where tool tip point rest at the work-piece.

Let 'h' be the height of deviation of the tool from centre of work-piece α is the angle formed at the centre of work-piece. As per construction α = C and correspondence angle, the amount reduce in clearance angle will be equal to 'C', where 'D' is the old top rake angle. So, new top rake angle will be equal to (C + D). Now previous clearance is 'C'. So, new clearance will be previous clearance (Q) - Increase in top rake angle. i.e., (Q - C).

Hence, finally it is obvious that if clearance angle decreases then tool face will be in contact with Work Piece, then rubbing will start and surface finish will be deteriorated.

For h amount (height from centre) and angle α, tool clearance angle should be





New clearance or required clearance, $\theta^1 = \theta + \alpha$

$$= \theta + \sin^{-1}(h / R) \text{ and}$$

$$\beta^1 = \beta - \sin^{-1}(h / R)$$

CONCLUSIONS

Hence we can conclude that for what height, deviation of tool when set, then what change in angle of tool should be set to get the correct result, where adverse effect on tool and work-piece will not occur. Thus we can get the greater accuracy of job/ work in turning operation.

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