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Effect of Nose Radius of TiAlN coated Carbide Tool Inserts on performance in Machining OHNS Steel

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Abstract: The tool inserts are frequently utilised in contemporary industry for turning operations as well as general machining operations. The machining experiments conducted on OHNS die steel, with TiAlN coated Tungsten carbide tool inserts. This research paper examines the effects of changing the nose radius, feed rate, and cutting speed individually while maintaining the other two constants when turning OHNS Steel with tungsten carbide tool inserts coated with TiAlN. It is examined how the tip radius of TiAlN-coated, tungsten carbide-tipped tool inserts affects machining.

Key Words: *Turning, Tool Inserts, OHNS Die steel, Nose radius*

1.Introduction

OHNS Steel is difficult to machine accurately and with the desired surface finish. The impact of cutting speed, feed rate, depth of cut, and machining time on machinability variables such machining force, surface roughness[1], and wear of the tool [2], has been studied by early researchers.

Using TiAlN coated tungsten carbide tipped tool inserts for various combinations of machining parameters,the authors of this work conducted experiments and assessed the impact of changing the tip radius on turning OHNS Steel.

2.Experimental Study

The experimental set-up records process characteristics such cutting force[3], surface bumipnes, tool wear, and tool tip temperature. In an experimental research, a dynamometer with a thermocouple setup was utilised to find the temperature that occurred during turning and the rate of material removal[4].

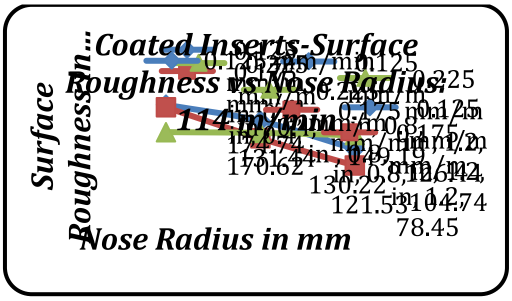
Figure 1: Lathe tool dynamometer with thermocouple set up

3.Result Analysis

The experimental outcomes for turning OHNS Steel utilising tungsten carbide tool inserts with various nose radii are displayed and analysed.

The inserts and work piece come into contact during a turning process. With changes in tool tip radius and tool orientation, the area of contact changes. Consequently, as the machining settings are changed[5], heat is produced in insert.

3.1 Variation of Surface Finish with nose radius[6]



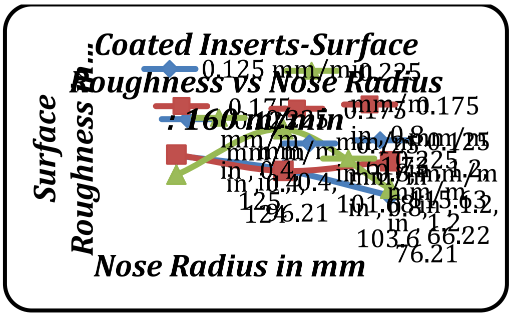


Figure2: Variation of Surface Finish with nose radius for cutting speed 114m/min.

Figure3: Variation of Surface Finish nose radius for cutting speed of 160m/min

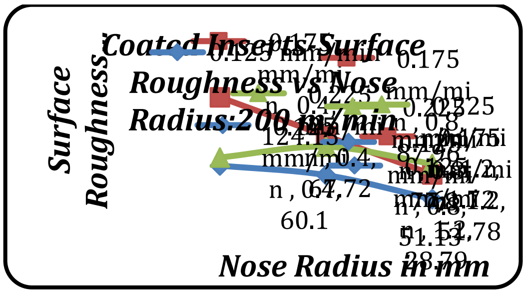


Figure3: Variation of Surface Finish with nose radius for cutting speed of 200m/min

From the figure 2 in case of coated condition with cutting speed 114m/min, surface detraction gradually decreases with increased tool tip radius at lower, moderate and higher feed rate conditions. It is observed that surface roughness high at low feed rate of 0.125 mm/min at 0.4,0.8 and 1.2 mm nose radius than the moderate and high feed rate in all nose radius. From the experimental data it is clears that surface detraction is 78.45µ low in moderate feed rate 0.175 mm/min at 1.2mm nose radius, than low and higher feed rate.

From the figure 3 in case of coated condition with cutting speed 160m/min, surface detraction gradually decreases with increased nose radius at lower, moderate but increases at higher feed rate conditions. It clears that surface roughness high at moderate feed rate of 0.175 mm/min at 0.4, and 1.2 mm nose radius than the low and high feed rate in respective nose radius but at 0.8 nose radius the surface bumpiness is high at 0.225 feed rates than lower and moderate feed rate. From the experimental data it clears that that surface bumpiness is 66.22µ low feed rate 0.125 mm/min at 1.2mm nose radius, than low and higher feed rate.

From the figure 3 in case of coated condition with cutting speed 200m/min, surface detraction gradually decreases with increased nose radius at lower feed rate and roughness increases in moderate and higher feed rate conditions wit increase in nose radius. It is clears that surface roughness high at 0.4, and 0.8 mm nose radius in the entire feed rate but at 1.2mm nose radius the surface detraction is lower in all the feed rate. From the experimental data it clears that that surface detraction is 28.79µ low feed rate 0.125 mm/min at 1.2mm nose radius, than moderate and higher feed rate.

3.2 Variation of tool wear with nose radius

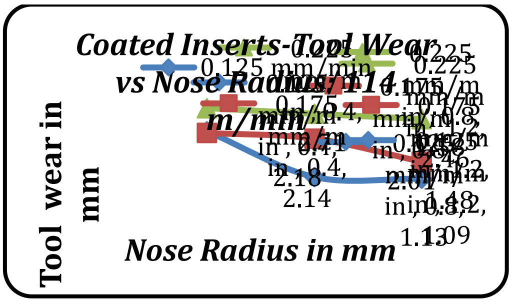


Figure4: Variation of tool wear with nose radius for cutting speed of 114m/min

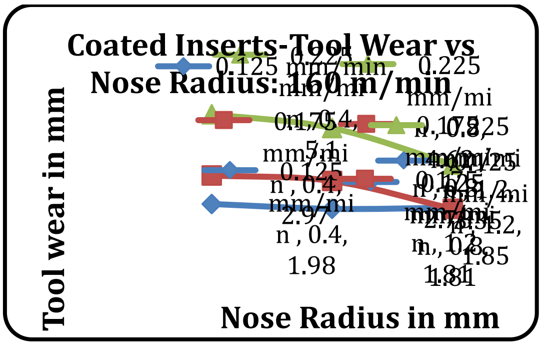


Figure5: Variation of tool wear with nose radius for cutting speed of 160m/min

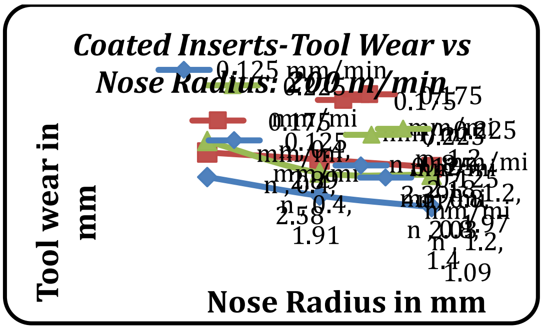


Figure6: Variation of tool wear with nose radius for cutting speed of 200m/min

From the figure 4, In coated condition with speed 114m/min, the tool wear decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the inserts wear is low at 1.2mm nose radius in all the feed rates but wear rate is high at 0.4 and 0.8 mm nose radius in all the feed rates. From the experimental data it clear that the value tool wears is 1.09mm at in low feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rates with same nose radius.

From the figure 5, In coated condition with speed 160m/min, the inserts wear decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that inserts wear is low at 1.2mm nose radius in all the feed rates but wear rate is high at 0.4 and 0.8 mm nose radius in all the feed rates. From the experimental data it clear that the value tool wears is 1.81 mm in low and moderate feed rate like, 0.125 0.175 mm/min 0.8mm and 1.2mm nose radius higher feed rates with 1.2mm nose radius.

From the figure 6, In coated condition with speed 200m/min, the inserts wear increases with increased nose radius at lower feed rate conditions but decreases at, moderate and higher feed rate conditions. It states that the inserts wear value is lower at 0.125mm/min in all nose radius, than 0.175 and 0.225 mm/min in all nose radius. From the experimental data it clear that the value of tool wears is 1.01 mm in low feed 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rates with same nose radius.

3.3 Variation of temperature with nose radius

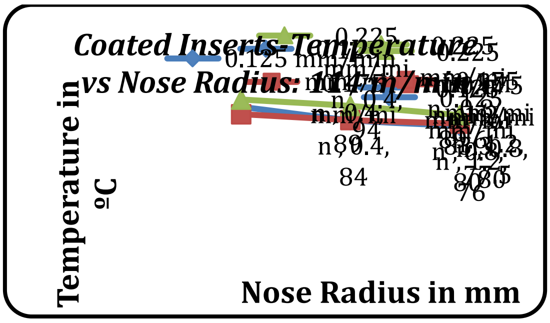


Figure7: Variation of temperature with nose radius for cutting speed of 114m/min.

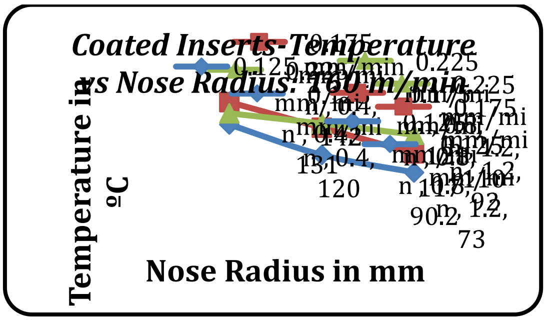


Figure8: Variation of temperature with nose radius for cutting speed of 160m/min

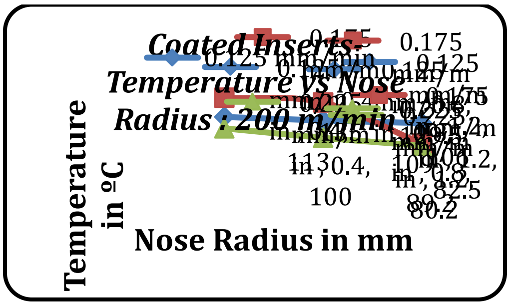


Figure9: Variation of temperature with nose radius for cutting speed of 200m/min

From the figure 7,in case of coated condition the temperature decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the temperature is low at 1.2 mm nose radius in all the feed rates but temperature is high at 0.4 and 0.8 mm nose radius in all the feed rates. From the experimental data it clear that the value temperature is 76°C in low feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rates with same nose radius.

From the figure 8, in coated condition the temperature decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the temperature is low at 1.2mm nose radius in all the feed rates than at 0.4 and 1.8 mm nose radius in all the feed rates. From the experimental data it clear that the value temperature is 73°C in low feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rates with same nose radius.

From the figure 9, in case of coated condition the temperature decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the temperature is low at 1.2mm nose radius in all the feed rates than at 0.4 and 1.8 mm nose radius in all the feed rates. From the experimental data it clear that the value temperature is 80.2°C in high feed rate 0.225 mm/min at 1.2mm nose radius than low and moderate feed rates with same nose radius.

3.4 Variation of MRR with nose radius

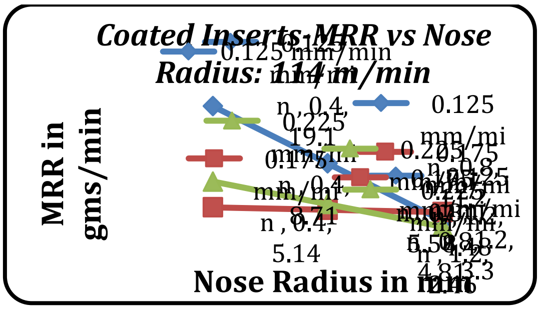


Figure10:Variation of MRR with nose radius for cutting speed of 114m/min

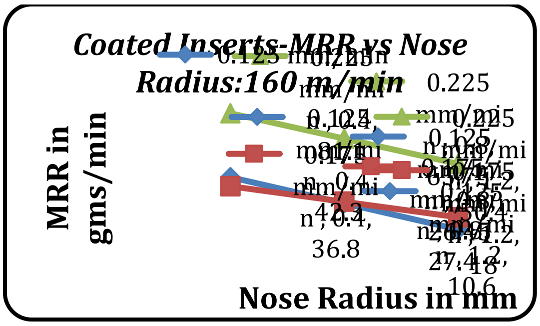


Figure11: Variation of MRR with nose radius for cutting speed of 160m/min

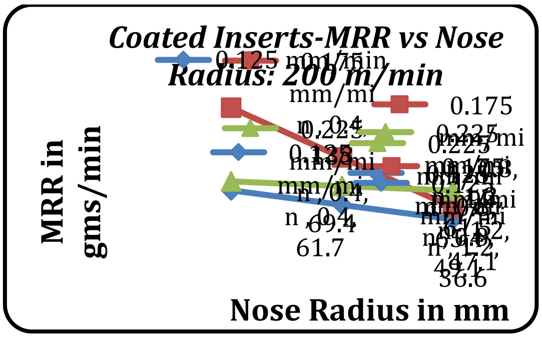


Figure12: Variation of MRR with nose radius for cutting speed of 200m/min

From the figure 10, in coated condition the MRR rate decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the MRR is low at 1.2mm tip radius in all the feed rates than 0.4 and 0.8 mm nose radius of all the feed rates. From the experimental data it clear that the value MRR is 2.46 gms/min in high feed rate 0.225 mm/min at 1.2mm nose radius than low and higher feed rate with same nose radius.

From the figure 11, in case of coated condition the MRR rate decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the MRR is low at 1.2mm nose radius in all the feed rates than 0.4 and 0.8 mm nose radius of all the feed rates. From the experimental data it clear that the value MRR is 10.6 gms/min in high feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rate with same nose radius.

From the figure 12, in case of coated condition the MRR rate decreases with increased nose radius at lower, moderate and higher feed rate conditions. It states that the MRR is low at 1.2mm nose radius in all the feed rates than 0.4 and 0.8 mm nose radius of all the feed rates. From the experimental data it clear that the value MRR is 36.6 gms/min in high feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rate with same nose radius.

3.4 Variation of cutting force with nose radius

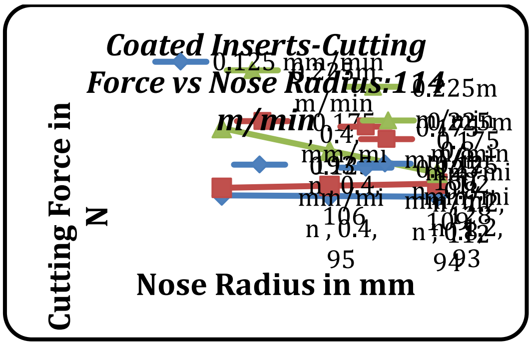


Figure13:Variation of cutting force with nose radius for cutting speed of 114m/min

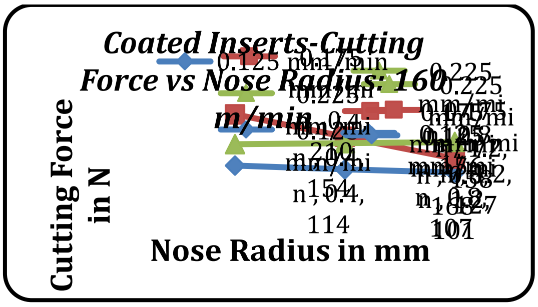


Figure14: Variation of cutting force with nose for cutting speed of 114m/min

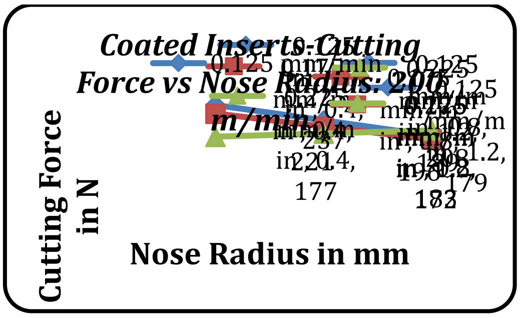


Figure15: Variation of cutting force with nose radius for cutting speed of 200m/min

From the figure 13, in case of coated condition the cutting force decreases with increased nose radius at lower and larger feed rate but increases at medium feed rate conditions. It states that the cutting force is low at 1.2mm nose radius in all the feed rates than 0.4 and 0.8 mm nose radius of all the feed rates. From the experimental data it clear that the value cutting force is 93 N in low feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rate with same nose radius.

From the figure 14 ,in case of coated condition the cutting force decreases with increased nose radius at lower and moderate feed rate but increases at higher feed rate conditions. It states that the cutting force is low at 1.2mm nose radius in all the feed rates than 0.4 and 0.8 mm nose radius of all the feed rates. From the experimental data it clear that the value cutting force is 101 N in low feed rate 0.125 mm/min at 1.2mm nose radius than moderate and higher feed rate with same nose radius.

From the figure 15, in case of coated condition the cutting force decreases with increased nose radius at lower and moderate feed rate but increases at higher feed rate conditions. It states that the cutting force is low at 1.2mm nose radius in all the feed rates than 0.4 and 0.8 mm nose radius of all the feed rates. From the experimental data it clear that the value cutting force is 172 N in moderate feed rate 0.175 mm/min at 1.2mm nose radius than low and higher feed rate with same nose radius.

3.5 Surface rughness analysis by SEM & EDXA

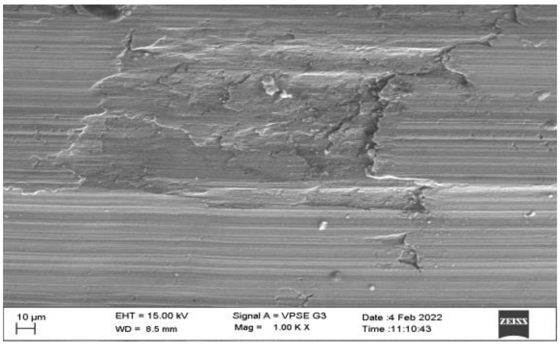
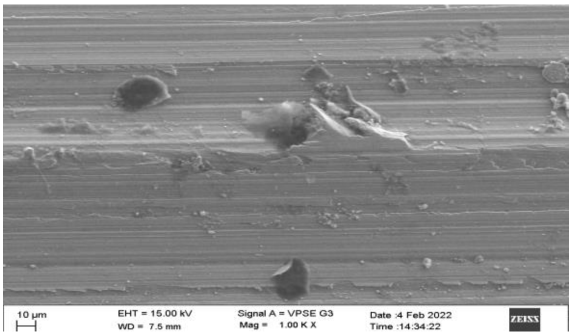


Figure16:SEM Photograph of Surface Roughness at 114 m/min with 0.225(mm/min) feed rate

Figure.17 : EDAX image of OHNS steel in coated condition with 114m/min



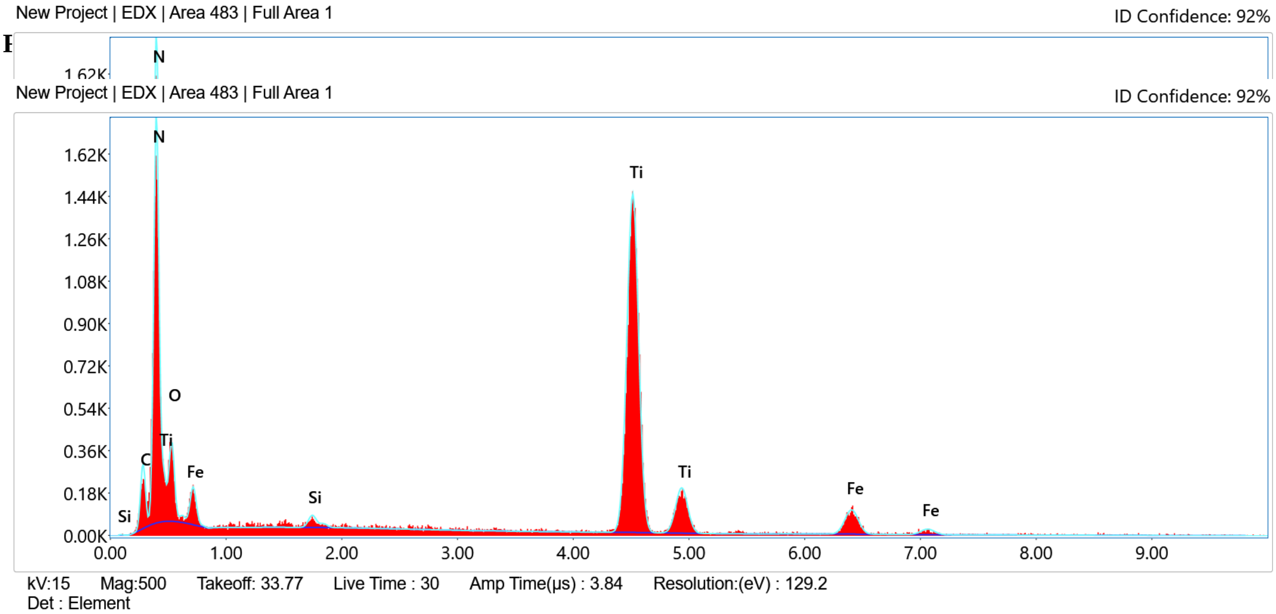


Figure.19 : EDAX image of OHNS steel at coated condition with 200m/min

Figure16: showes the surface roughhness of OHNS steel around 126.44 micron at the speed 114m/min with 0.225feed rate and 1.2mm nose radius.

Figure17: in coated condition amount of transportation is increase with increased machining parameter at with cutting speed 114m/min. The EDAX analysis confirms that elements associated with the coating carbide such as Fe and C are predominate and elements associated with the substrate materials are absent.

Figure18: showes the surface roughhness of OHNS steel around 61.72 micron at the speed 200m/min with 0.225feed rate and 1.2mm nose radius.

Figure19:In coated condition amount of transportation is increase with increased machining parameter at with cutting speed 200m/min. The EDAX analysis confirms that elements associated with the coating carbide such as TiAlN predominate and elements associated with the substrate materials are absent.

Surface finish improves for (TiAlN) coated tool inserts. Hence it is better to use (TiAlN) coated tool inserts for increased rates of speed feed and nose radius the surface.

4. Conclusion:

- As the nose radius increases, the surface smoothness gets better. A higher cutting speed will result in improved surface finish quality.
- When the nose radius is low, the rate of material removal is high; when the nose radius is high, the rate of material removal declines. The rate at which material is removed will rise as the feed rate increases.
- As nose radius increases, tool tip temperature lowers. At conditions of moderate cutting speed, the rate of temperature rise is greatest.
- As the nose radius increases, the flank wear of the TiAlN-coated tungsten carbide-tipped tool reduces. Higher feed rates will result in a slower rate of flank wear. When cutting at a faster rate, the rate of tool wear will be at its highest.
- At low and moderate feed rates, the cutting force applied to the tool tip reduces as the nose radius increases. With higher cutting speed circumstances, the rate of increase in cutting force accelerates.
- The machining conditions can be determined by carefully analysing the experimental results shown in coated condition with increasing nose radius for better surface finish, higher material removal, and reduced tool wear.
- From the experimental investigation it is observed that coated tools give better results as compared to uncoated tools in turning.

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