Performance of Tungstanium Carbide Coated PM HSS Tool in Machining Armour Steel

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***SUMMARY*-Armour steel possesses higher hardness and toughness and it poses considerable problem to the machinists compared to other conventional grade steels. The use of traditional cutting tools like HSS, PM HSS etc. is not giving considerable tool life and carbide cutting tools are comparatively expensive. Presently various coating techniques are available to enhance the performance of cutting tools. This paper deals with the performance of tungstanium carbide coated PM HSS tools in machining armour steel. Flankwear, tool life, specific power consumption and surface finish obtained in the case of plain PM HSS and tungstanium carbide coated PM HSS tools were compared to· evaluate the performance. The results showed that the coated PM HSS tools can be advantageously used for high volume metal removal at increased rates using higher cutting speeds.**

INTRODUCTION

Machining of armour steel poses problems to the machinists due to its higher hardness and toughness compared to other conventional grade steels. The use of traditional cutting tools like HSS, is not giving considerable tool life and satisfactory surface finish. From the point of view of economy, carbide cutting tools are costlier than HSS or even PM HSS tools. Hence it was decided to tryout PM HSS tools with tungstanium carbide coating for machining armour steel. PH HSS tools were chosen particularly because of their superior wear resistance, strength and toughness compared to plain HSS tools. PM produces a finer grain structure and uniform dispersion of carbides in the matrix. With a better homogeneity of alloying elements a uniform heat treatment becomes possible and higher hardness is attainable. Improved grindability facilitates tool making and resharpening [1]

Presently various coating techniques are available to enhance the performance of HSS tools. One such technique is the coating of tungstanium carbide (mixture of tungsten carbide and titanium carbide) by non-thermal diffusion process on HSS or PM HSS tools. The literature survey also reveals that the coating by non-thermal diffusion process on PH HSS tools have proved successful in improving their performance for machining conventional grade steels [2]. Non-thermal diffusion process coating has several advantages over conventional coating by physical vapour deposition or chemical vapour deposition. Here the temperature never exceeds 200'C and hence no deformation to the geometry, form or profile of the component coated. Base material remains unaffected and the coating material diffuses to a depth of 10 microns inside the tool face and is deposited by 7 to 12 microns over the surface of the tool. The diffused material can never peel, chip or rub off even under the most arduous machining conditions. Performance of tool is consistent even after prolonged use and the cost is nominal and proportionate to the cutting tool size [3].

This paper deals with the performance of tungstanium carbide coated PM HSS tools in machining armour steel. Experiments were conducted with coated and uncoated PM HSS inserts. Flank wear, tool life, specific power consumption and surface finish obtained in each ,case were compared to evaluate the performance.

EXPERIMENTAL

Machining trials were carried out on HMT A24 UP Pre-selector lathe on armour steel with plain PM HSS inserts and tungstanium coated PM HSS inserts. The material specification and experimental details are given in Table 1

TEST RESULTS AND DISCUSSIONS

Flank Waer Vs Time

Three sets of experiments were conducted by keeping the cutting speed at the nearabout recommended value but at different feeds and depths of cut. The flankwear at equal time intervals were measured and the results are graphically shown in fig. 1,2 and 3. It is seen from the graph that the amount of flankwear at all time intervals is much less in the case of tungstanium carbide coated PM HSS tool compared to the plain PM HSS tool. The difference in flankwear also increases with increase in machining time. It is seen from the above that the tungstanium carbide coated tool is definitely having better wear resistance compared to the uncoated tool.

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Table – 1

Machine tool	HMT A24 UP Preselector Lathe
Power of Motor	11.2 KW
Material Used	Armour steel 70 mm dia X 350mm long
Composition	C 0.25%, Si 0.2%, Mn 0.8%, Ni 1%, Cr 1.25%, Mo 0.25%, V 0.25%, S 0.08%, P 0.08%
Specification of inserts used	ISO TPUN 16 03 04
Tool Geometry Cutting speed range	6,ll,0,90,60,.4mm 7.04 m/min to l7l.5 m/min
Depth of cut range	0.9mm to 2.8 mm
Feed range	0.05mm/rev to 0.8lmm/rev
Cutting fluid	Soluble Oil (1:20)

ACCESSORIES USED

1. Universal Measuring Microscope (Carlzeiss) for measuring flank wear.
2. Perthometer for surface finish measurement.
3. Clampon multifonction metre for power measurement.

Flank Wear Vs Cutting Speed

Experiments were conducted at different speeds keeping the feed and depth of cut constant. The result is graphically represented in fig.4. It is seen that the coated tool is having lesser flankwear at all speeds compared to uncoated PM HSS. The difference is more pronounced at higher cutting speeds. Hence the coated PM HSS tool can be advantageously used for machining at high speeds thus enhancing the metal removal rate. Also the coating withstood the higher temperature associated with high speed machining.

Flank Wear Vs Depth of Cut

Machining trials were conducted by keeping feed speed constant and varying the depth of cut. The depth of cut was varied from 1 mm to 2.8 mm in steps of 0.2mm. the results are depicted in fig.5 graphically. It is seen that the coated tool had better wear resistance at all depths of cut and the difference in Flank wear was larger at higher depths of cut.

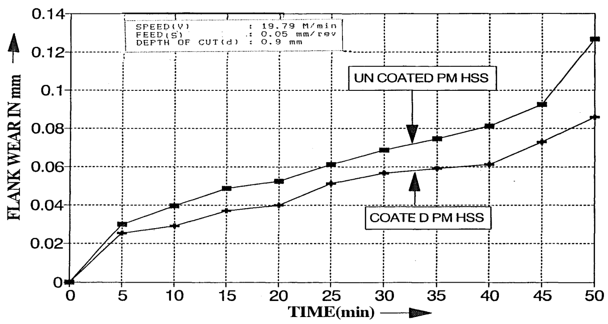

Fig 1 FLANK WEAR Vs TIME

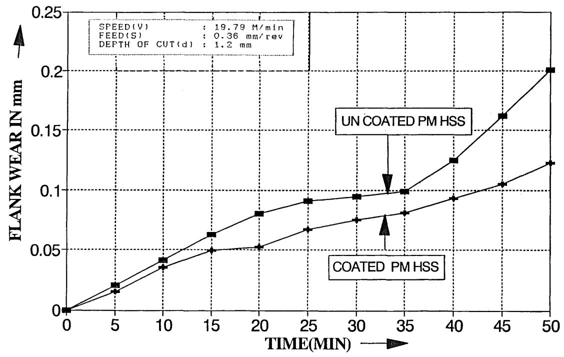

Fig 2 FLANK WEAR Vs TIME

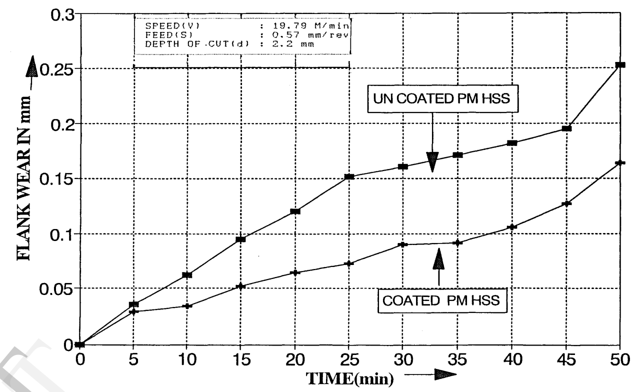

Fig 3 FLANK WEAR Vs TIME

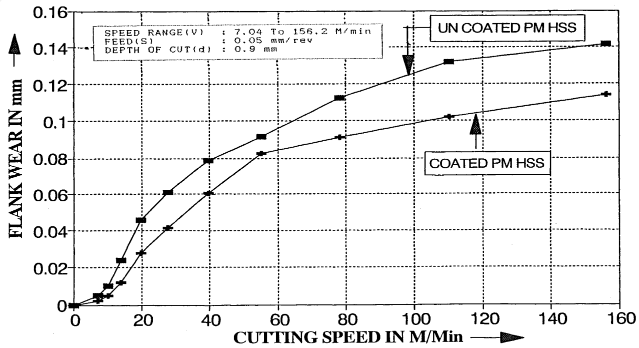

Fig 4 FLANK WEAR Vs CUTTING SPEED

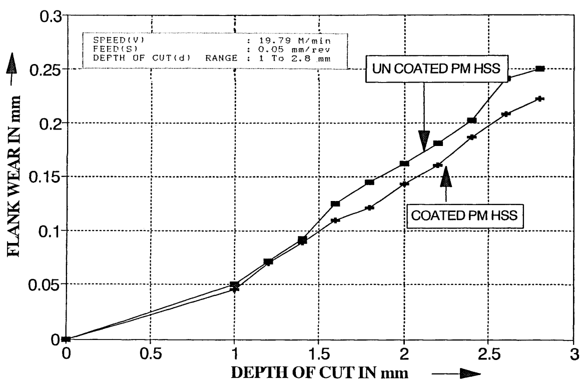

Fig 5 FLANK WEAR Vs DEPTH OF CUT

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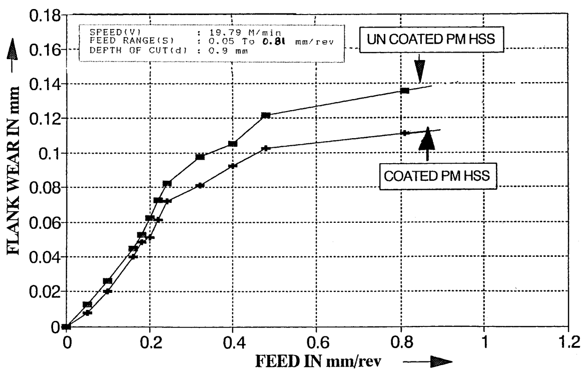

Fig 6 FLANK WEAR Vs FEED

Flank Wear Vs feed

Experiments were conducted keeping the speed and Depth of cut constant and varying the feed. The trials were conducted at the different feeds and the result is shown graphically in fig. 6. It can be inferred that the coated tool had better wear resistance at all feeds. Moreover the difference in flank wear was larger at higher feeds.

Figures 5 and 6 again confirm that the tungstanium carbide tool can be more advantageously used for high volume metal removal rates by using higher feeds and depths of cut.

TOOL LIFE STUDIES

Based on machining trials, the tool life criterion was selected as 0.15mm wear on the flank of the tool. Trails were conducted at four different speeds using the coated and uncoated tools. The result is shown graphically in fig.7. It can be seen that the difference in tool life between coated and uncoated tool is larger at higher cutting speeds thereby confirming that the coated tools can be advantageously used for high volume metal removal with increased rates of removal using higher speeds. The tool life is more than doubled in the case of coated tools.

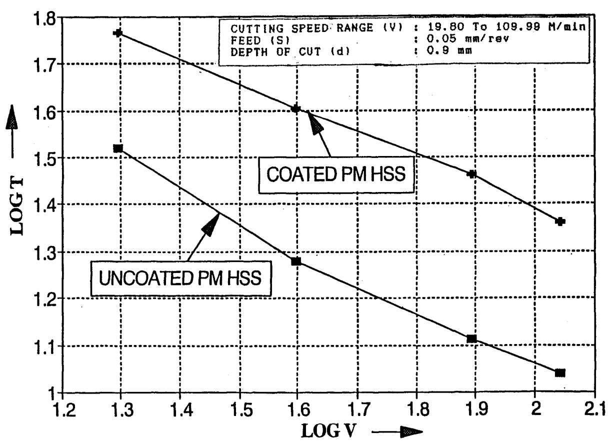

Fig 7 COMPARISON OF TOOL LIFE

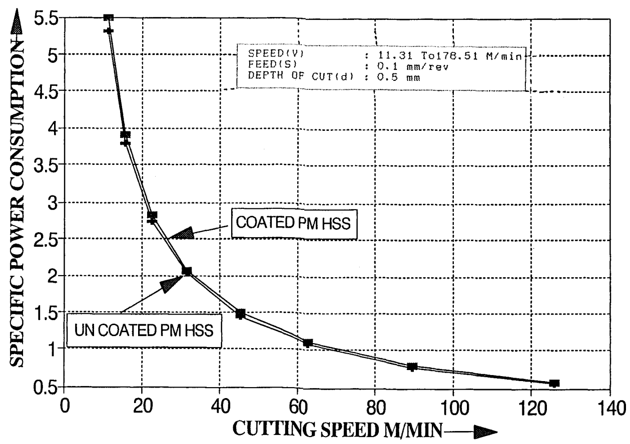

Fig 8 SPECIFIC POWER CONSUMPTION Vs SPEED

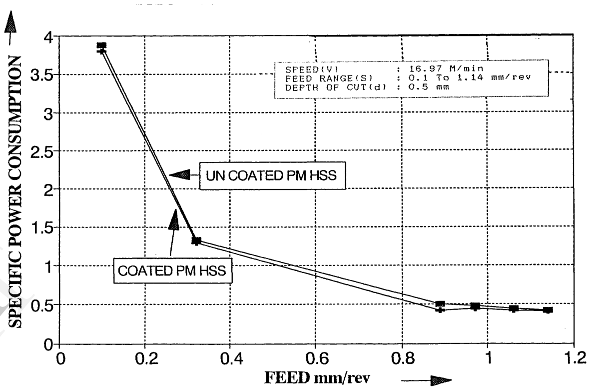

Fig 9 SPECIFIC POWER CONSUMPTION Vs FEED

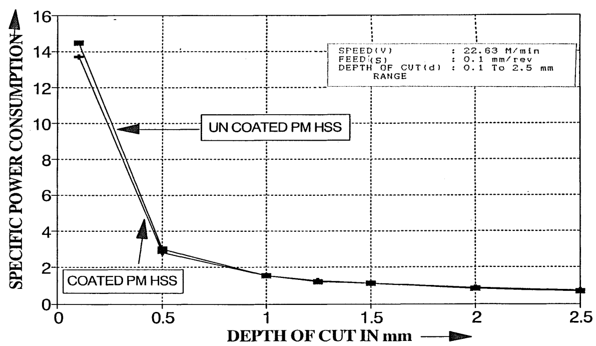

Fig 10 SPECIFIC POWER CONSUMPTION Vs DEPTH OF CUT

SPECIFIC POWER CONSUMPTION

Power consumption during machining was measured using clampon multifunction meter. specific power consumption variation between coated and uncoated tool with speed, feed and depth of cut were studied. The results are shown in graphs 8,9 and 10. There is no significant difference in specific power consumption between coated and uncoated tools except that specific power consumption vas marginally less in the case of coated tools.

SURFACE FINISH

Studies on the surface finish of the components machined with coated and uncoated tools were carried out for comparison. Machining trials were conducted keeping the cutting speed and depth of cut constant but varying the feed. After each trial the surface finish vas measured using PERTHO METER having an accuracy of 0.1 micron. The result is shown in fig.11 graphically. It is observed that the finish obtained in both the cases were satisfactory and within the limits for turning.

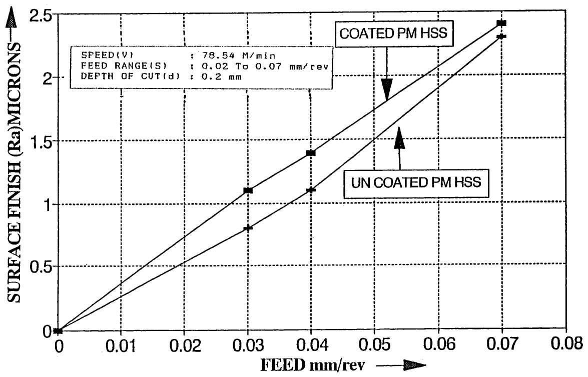

Fig 11 COMPARISON OF SURFACE FINISH

CONCLUSION

Coating of Tungstanium carbide by non-thermal diffusion process is indigenously available at a cheaper rate. Metallurgical studies conducted on coated inserts reveal that the bond between the layer and substrate is very good and the coating thickness is to the extent of 7 microns. Microstructure of coated inserts reveal that the characteristics of the substrate is retained.

The machining trials carried out at various speeds, feeds and depths of cut conclusively show that the coated tools have superior wear resistance at all cutting condition and hence can be

advantageously used for high volume metal removal at increased rates using higher cutting speed. The coating is able to retain its effectiveness even at higher temperatures associated with higher cutting speeds.

There is little difference in specific power consumption between coated and uncoated tools at all cutting conditions.

The surface finish of the machined components were within the limits for turning in both the coated and uncoated tools.

The tungstanium carbide coated PH HSS tool can serve as an ideal substitute for expensive carbide tools in rough machining armour steel.

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