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ANALYSIS ON TOOL WEAR OF PCD 1500 MEDIUM GRADE INSERT ON MACHINING AL-SIC METAL MATRIX COMPOSITE

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ABSTRACT:

This paper presents the investigation of tool wear of PCD 1500 grade insert on machining Al-SiC Metal Matrix Composite of 20% by weight of silicon carbide reinforcement particles. This experiment is carried out on medium duty lathe by setting different cutting conditions without the application of coolant. Parameters such as Power Consumed by main spindle, Surface Roughness and Tool Wear were analyzed. Result provides some useful information on tool wear against the percentage of reinforcement of silicon carbide particles.

Key words: Machining, Tool Wear, Al-SiC, Surface Roughness, Power Consumed

1. INTRODUCTION:

Increasing quantities of metal matrix composites (MMC's) are being used to replace conventional materials in many applications, especially in the automobile and recreational industries. The most popular types of MMC's are aluminum alloys reinforced with ceramic particles. These low cost composites provide higher strength, stiffness and fatigue resistance [1, 2, 3] with a minimal increase in density over the base alloy. Owing to the addition of reinforcing materials, which are normally harder and stiffer than the matrix, machining becomes significantly more difficult than in the case for conventional materials, as reported in the earlier publications [1-5]. The type of MMC studied in this paper for its machinability is reinforced with 20% of Silicon Carbide particles. A typical microstructure of the material is shown in fig – 1. The chemical composition of this MMC is shown in table – 1

Table – 1 Chemical Composition of The Work Piece -1 (20% Wt Of Sic)

Si	Fe	Mg	Zn	Pb	Ni	Zr	Mn	V
11.60	1.34	2.44	3.46	0.184	0.970	0.432	0.379	0.0517

Microstructure of The Work Piece

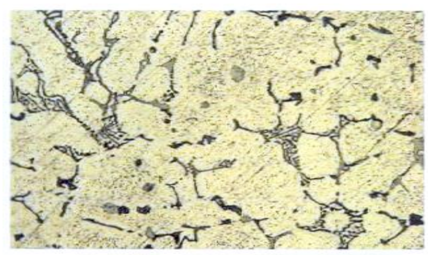
1ml HF + 200 ml H2o 500 X

Fig-1 (20% by weight of SiC)

2. EXPERIMENTAL PROCEDURE:

The 20 percentage by weight of Al-SiC MMC having dimension of 200 mm * 60 mm were machined with PCD 1500 medium grade insert at three different cutting speeds (50 – 200 m/min) with three different feed rates (0.108 – 0.120 mm/rev) and three depth of cut (0.5,0.75 and 1mm). The use of PCD insert in this study is due to its excellent performance compared with High Speed Steel Tool when machining Aluminium MMC [5]

The Surface Roughness and Power Consumption were measured at predetermined intervals. Other parameters like Material Removal Rate and Specific Power Consumption were calculated using the Cutting Speed, Feed and Depth of Cut. Each trial is machined for 2 minutes duration. At the end of the trial, surface roughness and power consumed were

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measured and graphs were plotted for various parameters. From the graph, best parameters were analyzed with reference to the surface finish obtained. By setting these parameters as a constant the work piece was machined to study the tool wear. Surface roughness was measured using Mitutoyo Surf Test (Series 178), Tool Wear was measured by using Tool Maker's Microscope of 100X magnification and Power Consumption was measured by two watt meter method.

3. RESULTS AND DISCUSSION:

3.1 Effect of cutting speed on surface finish:

In Fig-2 As cutting speed increases surface finish value (R_a) decreases . This is happening because of the formation of Built Up Edge (BUE) which is substantial at high cutting speeds. The same trend exists for other parameters also.

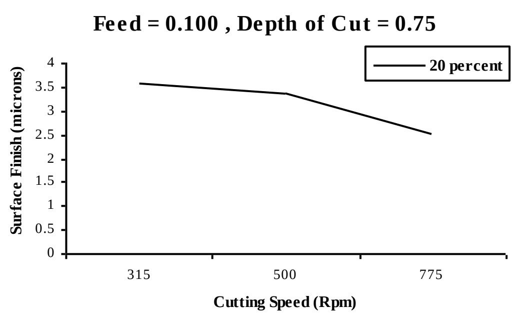


Fig - 2 Effect of cutting speed on surface finish

3.2. TOOL WEAR:

In Fig-3 (a, b) shows Magnification of 100X. It is evident that machining Al-SiC (20p) for continuously 100 minutes of duration, tool flank wear of 0.4 mm is obtained. It is because of the fact that the silicon carbide particles in the matrix metal increase the flank wear of tool by abrasion of hard particle

Fig - 3(a)

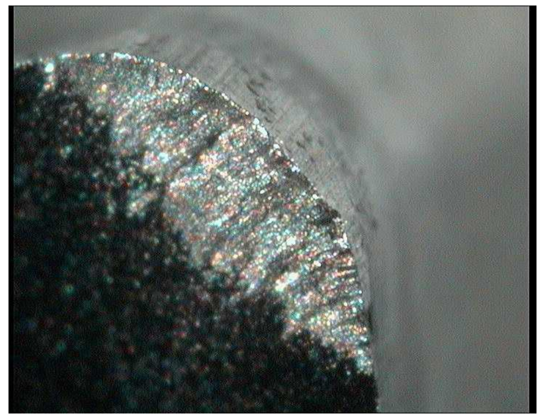


Fig - 3(b)

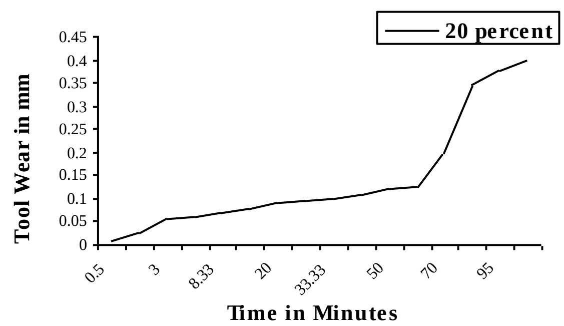


Fig – 4 Tool Wear of 20 % by weight of Al-SiC MMC

3.3. POWER CONSUMED:

In Fig –5, power consumed decreases when cutting speed increases, it is found that at high cutting speed power required to machine the material is less. It is evident because of the fact that at high cutting speeds, friction between the cutting tool and work piece is less. Same trend is continuing in other parameters also.

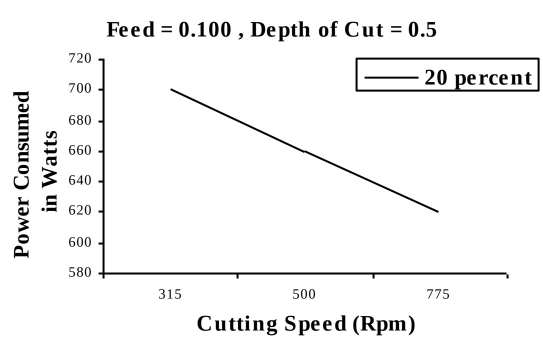
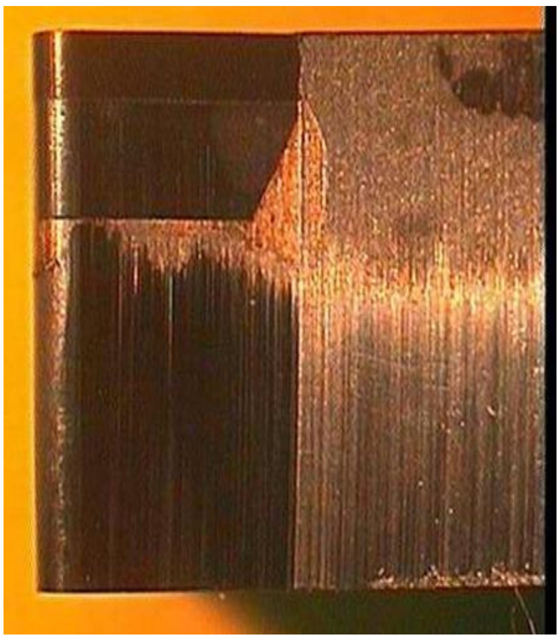


Fig -5 Effect of cutting speed on power consumption

Fig 6 – Photograph of Fresh PCD 1500 Tool



CONCLUSION

The following conclusions can be drawn from the results of this investigation:

1. The main type of tool wear during machining Al-Sic Metal matrix take places on the flank and the rake surfaces, with flank wear being dominant in the quoted speed –feed range. The primary mechanism of wear formation is believed to be the abrasion between reinforcement particles and cutting tool material. This is common for machining both the work piece. Tool wear is more at work piece having more silicon carbide percentage by weight

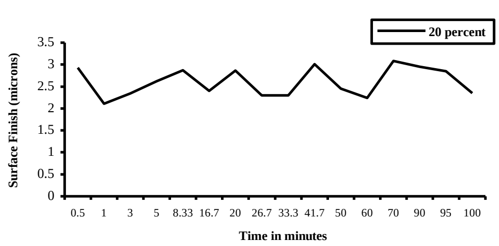


Fig – 6 Effect of time on surface finish

2. The surface finish of the machined samples deteriorates with increasing feed rates. PCD 1500 insert was performed well in all aspects. The best surface finish is obtained at high speed with low feed rate.

3. Increase in the surface finish and reduction of tool wear is possible while machining these MMC's at high cutting speed because MMC and PCD tools are specially meant for high speed machining.

4. Grain size of the reinforcement particles and volume fractions are strongly influencing the tool wear.

5. Only flank wear is observed on the cutting edge. There is no formation of crater wear.

6. While machining Al-SiC MMC of 20% by weight with PCD tool, groove wears were observed on the flank portion. These grooves are parallel to the cutting edge.

REFERENCE:

[1] F.E. Kennedy, A.C. Balbahadur, D.S. Lashmore, The friction and wear of Cu-based silicon carbide particulate metal matrix composites for brake applications, Wear 203/204 (1997) 715-721

[2] A. Ravikiran, M.K. Surappa, Effect of sliding speed on wear behavior of A356 Al 30 wt % SiCp MMC, Wear 206 (1997) 33-38

[3] J.E. Allision, G.S. Gole, Metal-matrix composites in the automotive industry: opportunities and challenges, J. Min. Met. Mater. Sci. 45 (1) (1993) 19-24.

[4] L.A. Looney, J.M. Monagham, P. O'Relilly, D.M.R. Taplin, The turning of Al/SiC metal-matrix composites, J. Mater. Process, Technol. 33(4) (1992) 453-468.

[5] M.M. Schwartz, Composite materials processing, fabrication, and Applications, Prentice- Hall, Englewood Cliffs, NJ, 1997main type of tool wear during machining Al-Sic Metal matrix take place on flank