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TEMPERATURE DISTRIBUTION WHILE GRINDING Al / SiC_P COMPOSITES

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ABSTRACT

The grinding process requires a high energy input per unit volume of material removed which is converted to heat at the grinding zone. This results in increased temperature and possible thermal damage. An attempt has been made to study the temperature involved while grinding composite material with different grinding wheels in both dry and wet conditions. Experiments were carried out in a surface grinding machine. Temperature measurements were made using copper constantan thermocouple wires. Grooves were made in the workpiece and the thermocouple was installed in the workpiece with mica insulators between the wire and the workpiece. Prior to carry the tests the thermocouple was calibrated. The workpiece material was LM 25 Aluminium Silicon Carbide particulate metal matrix composites. Different types of wheels like Silicon Carbide (SiC), Cubic Boron Nitride (CBN) and Diamond Wheels were used. The influence of grinding parameters like work speed, wheel speed and depth of cut were studied while grinding composites with different types of wheels .The measured interface temperature between the wheel and workpiece is not more than 110˚C. The diamond wheel exhibits low temperature followed by CBN wheel and SiC wheel. The temperature increases with increase in grinding parameters. The temperature distribution in the workpiece was limited to a very small depth and it can be assumed that thermal damage to the subsurface layers may not be considerable. The influence of coolant is also studied and the effect is marginal.

KEYWORDS – COOLANT, DEPTH OF CUT, THERMOCOUPLE, WHEEL SPEED, WORK SPEED.

1. INTRODUCTION

Grinding is one of the major manufacturing process which accounts for about 20-25% of the total machining operations. All the energies expended by grinding is converted into heat which is concentrated within the grinding zone. One of the most common types of thermal damage is workpiece burn while grinding plain carbon and alloy steels. Workpiece burn is characterized by bluish temper colour on the workpiece which are consequence of oxide layer formation .At the onset of burning there is a tendency of increased adhesion of metal particles to the abrasive grains thereby causing the forces to grow, the work piece surface deteriorates and the rate of wheel wear to increase. Another thermal damage is tempering of steels by grinding heat which softens the workpiece near the finished surface. The grinding surface also produces residual stress in the finished surface, which affects the mechanical behaviour of the materials.

2. EXPERIMENTAL SETUP

The experiments were carried out in a horizontal surface grinder with a single wheel speed and the wheel speed can be varied infinitely within a range. The temperature measurements were carried out using a copper-constantan thermocouple. A split workpiece in which grooves are cut along the depth of workpiece and copper-constantan thermocouple wires are sandwiched between the mica sheet insulators. Figure 1 shows the arrangements of the thermocouple in the workpiece. Prior to the tests the thermocouple was calibrated using furnaces which are having the digital temperature output facilities. Experiments were conducted by using wheels like Silicon Carbide (SiC), Cubic Boron Nitride (CBN) and Diamond Wheels by varying the wheel speed, work speed and depth of cut.

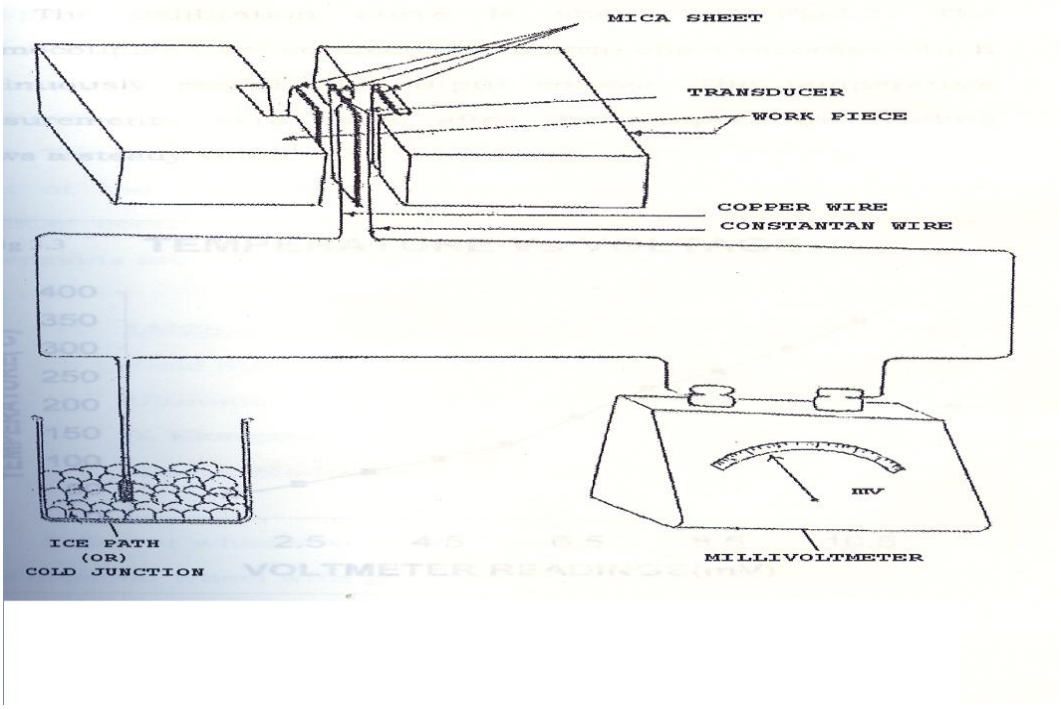

FIGURE 1: ARRANGEMENT OF THERMOCOUPLE IN THE WORKPIECE

3. EXPERIMENTAL MEASUREMENT OF TEMPERATURE

3.1. INFLUENCE OF DEPTH OF CUT

The wheel speed and work speed is kept constant and the depth of cut is varied and the measured values are shown if Figure 2 shows the variation of temperature against depth of cut. For CBN and diamond the rate of increase in temperature is almost linear. For SiC after a certain stage the rate of increase decreases whereas in case of CBN the temperature decreases and then increases. The temperature is high for diamond at 0.02 mm and temperature is high for CBN at 0.01 mm and 0.025 mm.

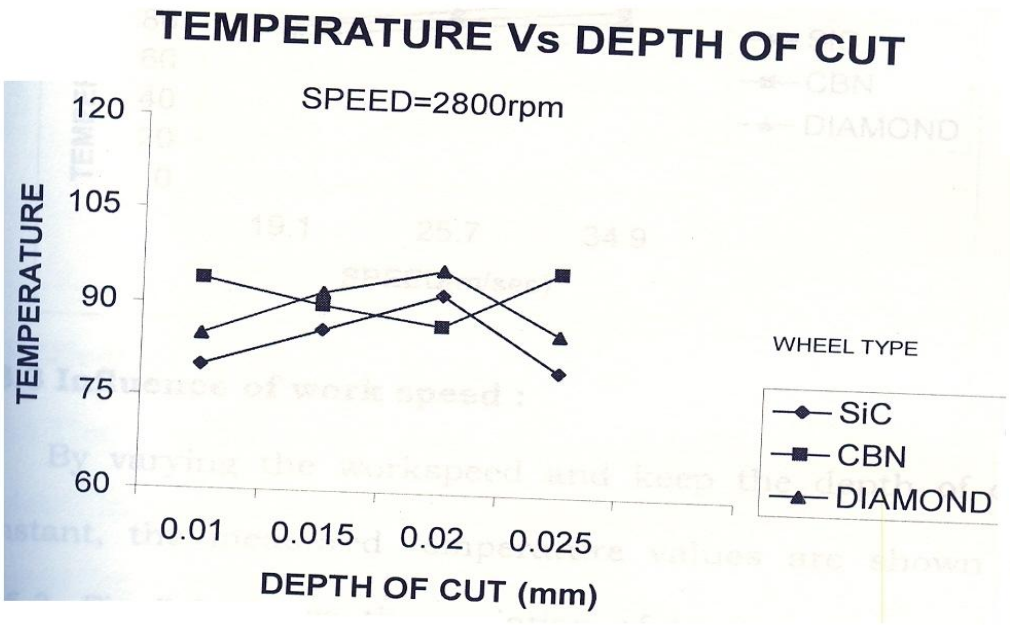

FIGURE 2: TEMPERATURE Vs DEPTH OF CUT

3.2. INFLUENCE OF WORK SPEED

The wheel speed and depth of cut is kept constant and the work speed is varied and the measured values are shown if Figure 3 shows the variation of temperature against work speed. For CBN and diamond the rate of increase in temperature is almost linear. For SiC after a certain stage the rate of increase in temperature decreases.

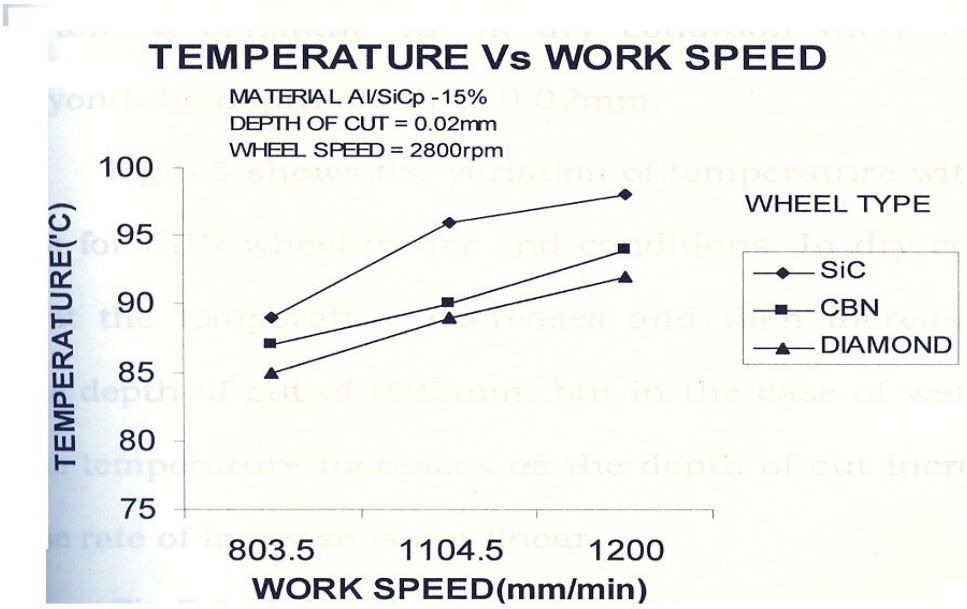

FIGURE 3: TEMPERATURE Vs WORK SPEED

3.3. EFFECT OF COOLANT

There are various types of oils which can be used as a coolant. In our experiment we have selected as a coolant for study.

3.3.1. INFLUENCE OF DEPTH OF CUT

The wheel speed and work speed is kept constant and the depth of cut is varied and the measured values and variation of temperature against depth of cut in dry and wet condition is given in Figure 4 to Figure 6.

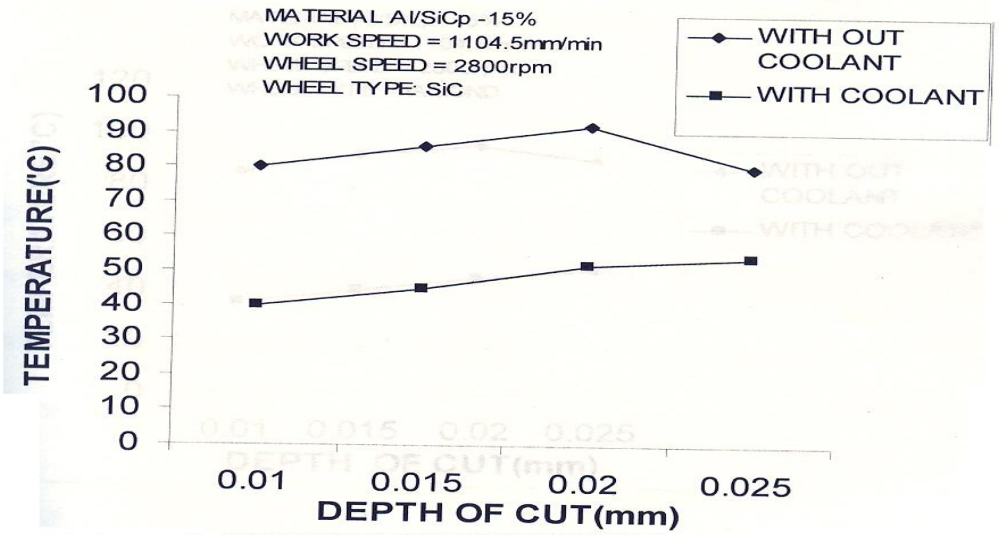

Fig. 4 TEMPERATURE Vs DEPTH OF CUT FOR SiC WHEEL

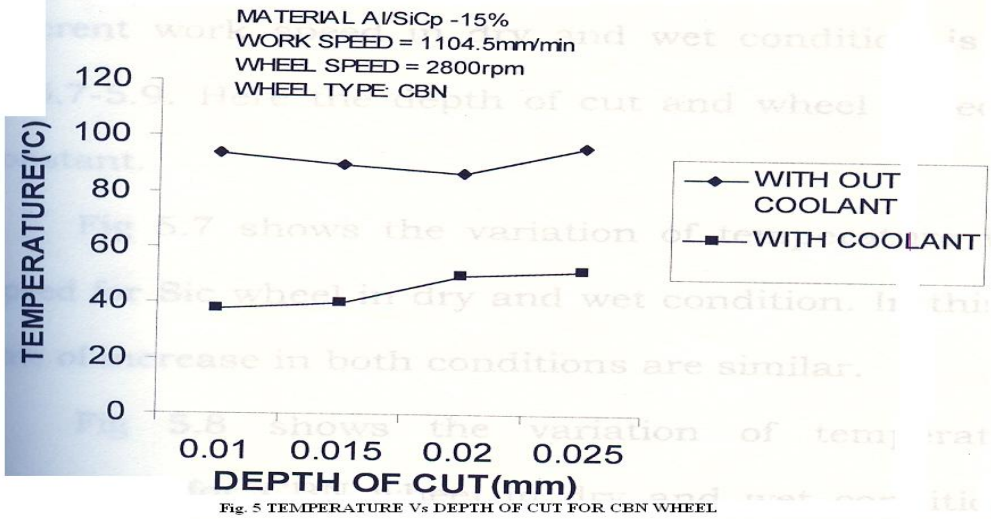

Fig. 5 TEMPERATURE Vs DEPTH OF CUT FOR CBN WHEEL

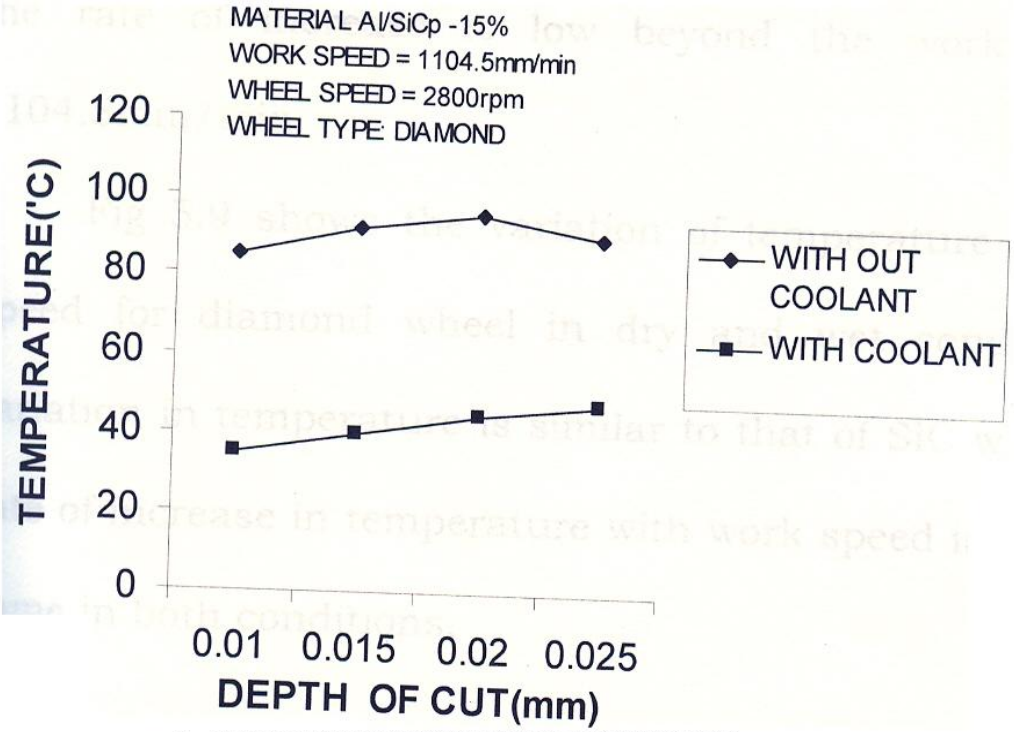

Fig. 6 TEMPERATURE Vs DEPTH OF CUT FOR DIAMOND WHEEL

For SiC wheel the rate of increase in wet condition is almost linear but in dry condition the rate of increase decreases beyond a certain limit. For CBN wheel the rate of increase in dry condition is almost linear, but in wet condition the temperature increases but the rate of increase is not linear. For Diamond wheel the rate of increase in dry condition is almost linear, but in wet condition the temperature increases almost linearly.

3.3.2. INFLUENCE OF WORK SPEED

The wheel speed and depth of cut is kept constant and the work speed is varied and the measured values for the variation of temperature against work speed in dry and wet condition is given in Figure 7 to Figure 9.

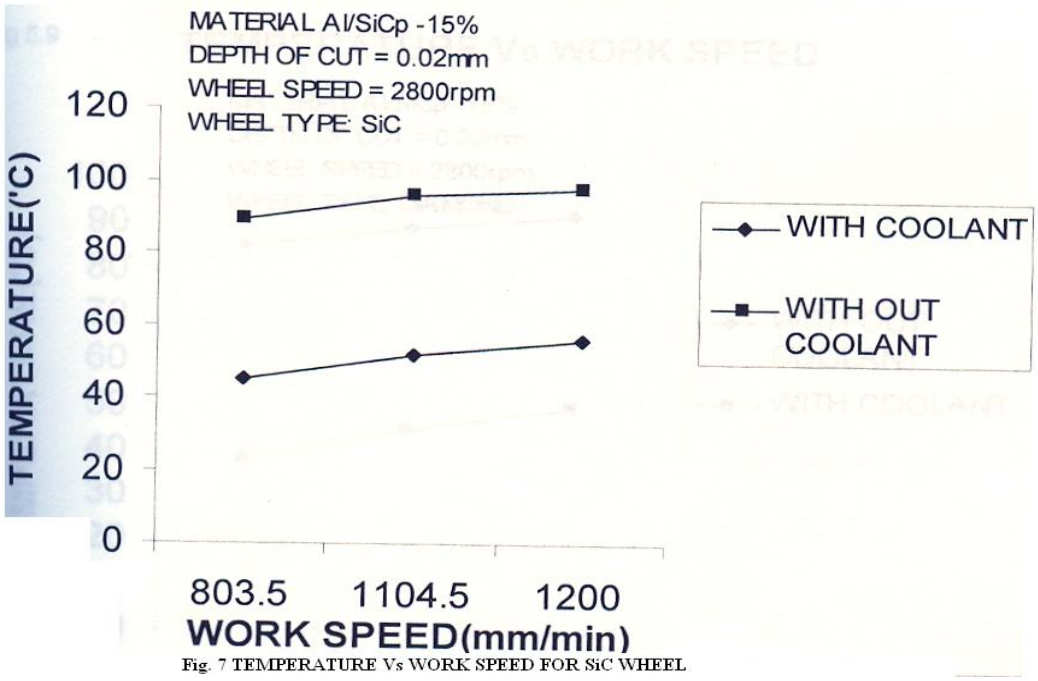

Fig. 7 TEMPERATURE Vs WORK SPEED FOR SiC WHEEL

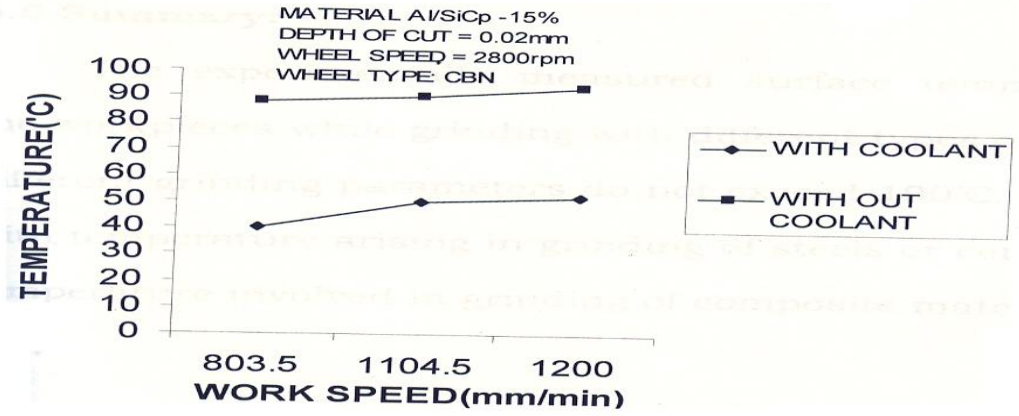

Fig. 8 TEMPERATURE Vs WORK SPEED FOR CBN WHEEL

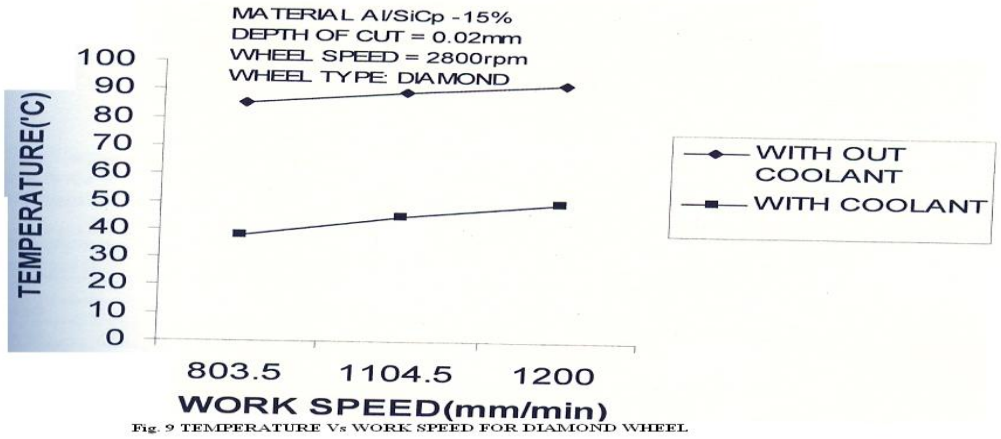

Fig. 9 TEMPERATURE Vs WORK SPEED FOR DIAMOND WHEEL

For SiC wheel the rate of increase in both wet condition and in dry condition the rate of increase in temperature is almost linear. For CBN wheel the rate of increase is high beyond a limit in dry condition whereas it is low in wet condition. For diamond wheel the rate of

increase in both wet condition and in dry condition the rate of increase in temperature is almost the same.

CONCLUSIONS

While grinding composite material the temperature is low which is around 100˚C which is very much low to that of grinding steel and ceramics in which the temperature is around 500˚C. When coolant is used the temperature is reduced to about 45%. Increase in work speed, depth of cut and wheel speed increases the temperature to certain extends.

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