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(Research article)

# Experimental Setup for Thermal Analysis of Machine Tool during Cutter Grinding Operation

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**_Abstract_**

*During machining various challenges are encountered like the generation of unwanted amount of heat which leads material failure. Finite element method (FEM) is the main tool or approach that has been used by researchers to evaluate results for almost every problem to observe the variation in data for experimental results and simulated results. Our experimental set up gives us an inkling what considerations should we follow in order to predict the optimum & efficient results. In the present work we are taking numerous work pieces of multiple facets. The proposed model is a transient varying state, curvy-linear problem that can calculate the optimum temperature and force fields on the work piece. In this paper, the different types of materials as mild steel, nikel- chromium steel and stainless steel are used.*

***Keywords:*** *Grinder, Thermal, structural, Heat affected zones, forces.*

## Introduction

The grinding machine consists of a power driven grinding wheel spinning at the required speed (which is determined by the wheel's diameter and manufacturer's rating, usually by a formula) and a bed with a fixture to guide and hold the work-piece. The grinding head can be controlled to travel across a fixed work piece or the work piece can be moved whilst the grind head stays in a fixed position. Very fine control of the grinding head or tables' position is possible use in a vernier calibrated hand wheel, or using the features of NC or CNC controls. Grinding machines remove material from the work piece by abrasion, which can generate substantial amounts of heat. They therefore incorporate a coolant to cool the work piece so that it does not overheat and go outside its tolerance. Grinding modeling has been a main concern of the researchers dealing with this process due to the difficulties raised in its experimental studying. A lot of models have been used for the mechanical and thermal simulation of grinding and of its components, mainly the work piece, the grinding wheel, the chip and the coolant. Especially, the thermal modeling of grinding has been extensively investigated because of the importance of the knowledge of the maximum temperature reached during the process and, consequently, of the thermal damage induced to the work piece because of excessive heat loading. This heat input is responsible for a number of defects in the work piece like metallurgical alterations, micro cracks and residual stresses. The areas of the work piece that are affected are described as heat affected zones.

Fig.1 show presentation of machined work specimens: Stainless steel, Mild steel and High Chromium steel

## 2. Experimental Set Up

A tool and cutter grinder is used to sharpen milling cutters and tool bits along with a host of other cutting tools. It is an extremely versatile machine used to perform a variety of grinding operations: surface, cylindrical, or complex shapes. The image shows a manually operated

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setup. An experimental set-up is developed for the measurement of forces and temperature during the grinding process. In this setup Tool and cutter grinder is used for experiments which are derived through an electric motor and with the help of flat belt. In this setup there is a possibility to vary the rpm of motor i.e 5500 and 4000 rpm. The grinding wheel is mounted on the arbor and is placed in the proper position so that grinding is possible. Before commencement of experiment, proper height of table is set with the help of hand lever which is mechanized with the help of tail and pinion mechanism. The dynamometer is mounted on the table with the help of fasteners which are further tightened on T- slots. The work piece is mounted on a dynamometer (Kistler 9257A) linked to an acquisition data system in order to measure also the loads during grinding. The force is displaced on the display meter which is connected with the dynamometer. Cross slide is used for giving a motion to the table in y-axis which is operated with the help of gear mechanism. Dial gauge indicator is used to calculate the depth of cut which is given to the work piece. The dial gauge is having a plunger which is moving in to and fro motion. As it moves in up and down motion, indication is given on the dial gauge. The least count of dial gauge indicator is 0.01 mm. As we start the motor, grinding wheel is rotated at particular rpm according to the positioning of flat belt and work piece is mounted on the dynamometer. As grinding wheel start machining forces are displayed on the display meter of the dynamometer and we get final readings of force. Temperature is measured with the help of thermometer using thermocouple.

The materials of the work piece used in the study are mild steel, stainless steel and high chromium steel with Rockwell hardness vary from 43 to 44, 53 to 54 and 54 to 55 respectively Rockwell hardness number on scale C. Material compositions for different materials are checked using spectrometer testing machine and found the % of carbon in mild steel is 0.165% and 0.343% for high carbon steel and 0.050% for high chromium steel.

Fig.2 Experimental setup

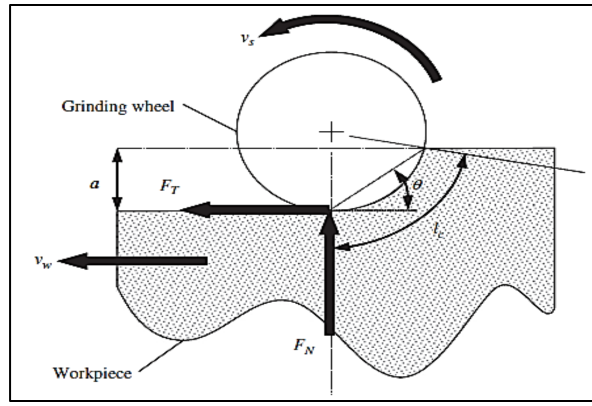


Fig. 3 Process Parameters

## 3. Results and Discussion

In the present study, diamond type of grinding wheel is used for grinding. As shown in figures force vs. time and temperature vs. time for three depths of cut were used, namely 0.03, 0.06 and 0.09 mm while the grinding speed was 4000 and 5500 rpm. The feed rate taken to perform this experiment is 0.0667 and 0.1 mm/rev.

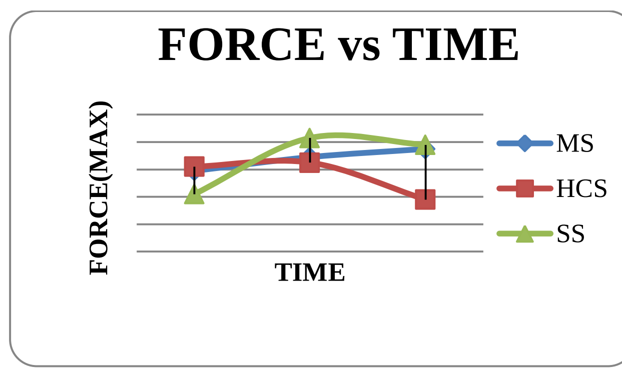


Fig.3.1 (a) Variation of force V/s time

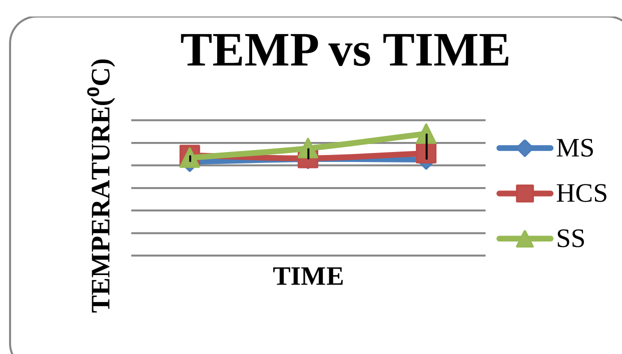


Figure 3.1 (b) Variation of temp V/s time

Fig.3.1 Process parameters as speed: 4000 rpm, feed: 0.0667 mm/rev and DOC: 0.03mm

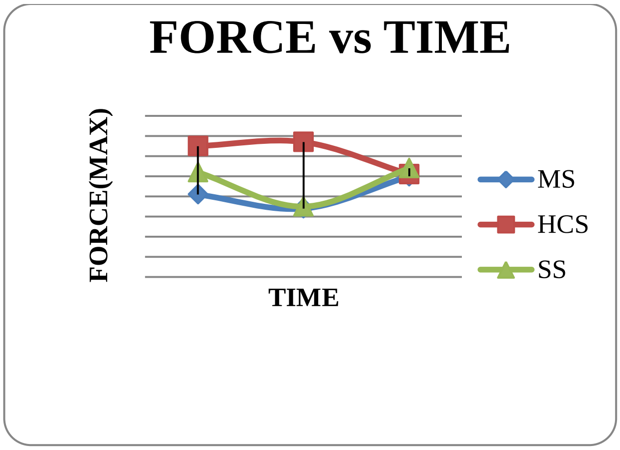


Fig. 3.2 (a) Variation of force V/s time

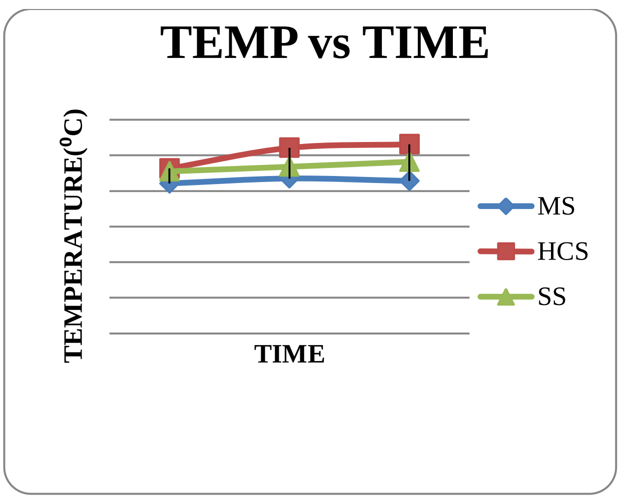


Fig. 3.2 (b) Variation of temperature V/s time

Fig.3.2 Process parameters as speed: 4000 rpm, feed: 0.1 mm/rev and DOC: 0.03mm

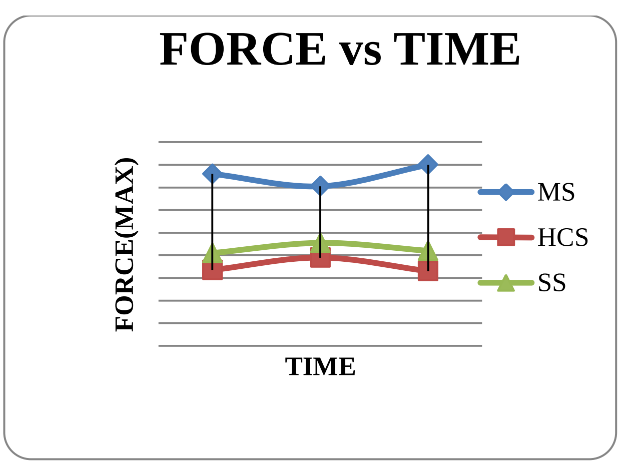


Fig.3.3 (a) Variation of force Vs time

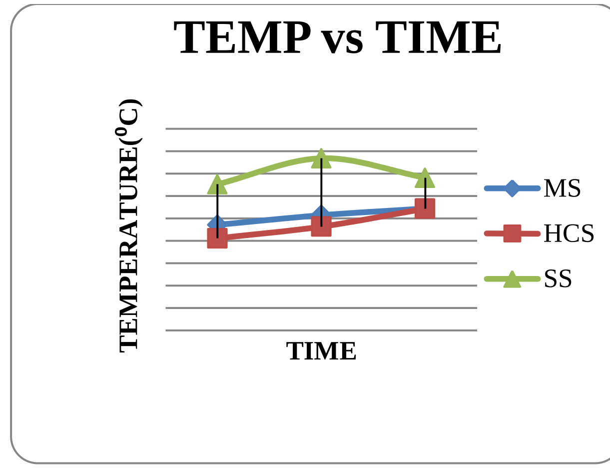


Fig.3.3 (b) Variation of temperature V/s time

Fig.3.3 Process parameters as speed: 5500 rpm, feed: 0.0667 mm/rev and DOC: 0.09mm

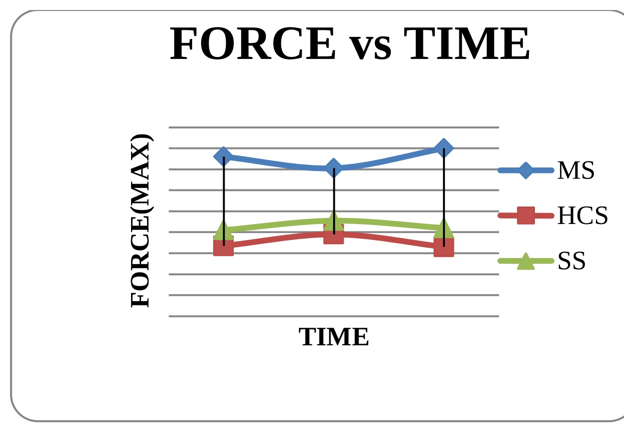


Fig. 3.4 (a) Variation of force V/s time

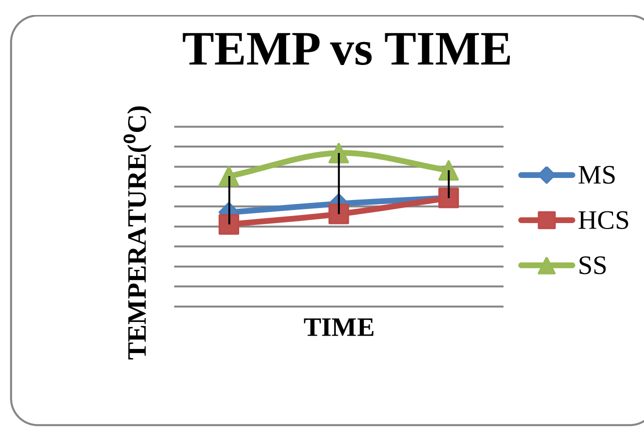


Fig. 3.4 (b) Variation of temp V/s time

Fig.3.4 Process parameters as speed: 5500 rpm, feed: 0.1 mm/rev and DOC: 0.09mm

## 4. Conclusion

Machine tools are often exposed to high temperature during machining various challenges are encountered like the generation of unwanted amount of heat which leads material with high temperature significant thermal stresses may develop and cause warpage or failure of cutting tool. In this experimental study the main objective of the present work is to collect the data based on four parameters i.e. speed, feed, machining time and depth of Cut. On the basis of present study following conclusions have been drawn:

- According to experimental data the cutting force during cutting operation is maximum for stainless steel in comparison to mild steel and high carbon steel.
- But the temperature is minimum for mild steel in comparison to stainless steel and the chromium steels.
- With increasing the depth of cut the temperature will also increases for all three metal pieces.

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