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# Determination of the Turning Knife Thermal Stress during Longitudinal Turning

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**Abstract:** A turning knife enters a work piece during turning. Due to friction, heat is produced proportionate to the turning speed. The resulting temperature influences the quality of the machined surface and wear of the knife. Thus, new machine tools must be developed which minimize the production of unwanted heat. To accomplish this task, a new experimental device has been prepared, where thermocouples were built into the knife and surface thermocouples were welded onto its surface. The measurement process was supplemented by thermovision. Heat flux and surface temperatures were computed from the subsurface data using a one-dimensional inverse task. A detailed temperature distribution on the surface of the turning knife was determined using a combination of these methods.

## Introduction

An understanding of turning tool thermal stress is very important due to its influence on surface quality and tool wear, but more importantly for the development of better cutting tools. Currently, there are a number of contact and non-contact methods using various instruments to measure this stress. For this study, shell thermocouples, thermocouple wires and a thermal imaging camera were used. To determine the surface temperature and heat flux at the point of heat generation (the contact-point of the work piece and a tool), a one-dimensional inverse task was used.

## Experimental measurements

The experiment was performed using a Radeco side turning tool. Firstly, 20 mm deep and 0,6 mm wide holes were created 1 mm under the surface and 2 mm from the tool tip using electro-erosion, and then were fitted with 0,5 mm shell thermocouples. Secondly, thermocouple wires were welded to the blade surface to record the surface temperature - see Fig. 1 and 2. Finally, a detailed view of the temperature field of the tip of the tool was obtained using a ThermaCAM SC 2000 thermal imager. Three experiments with different cutting speeds were performed [1].

Fig. 1: Tool with thermocouples,

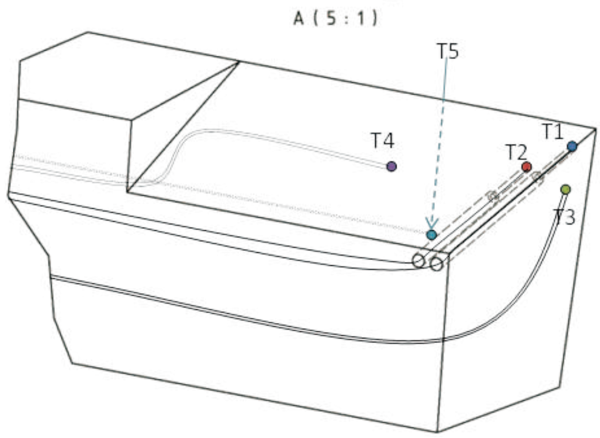
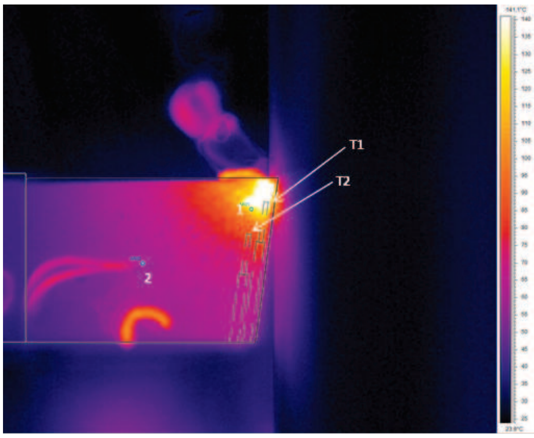



Fig. 2: Position and indication termocouple

## Results

The thermogram in Fig. 3 shows the areas where the temperature record was recorded - T1 and T2 stand for the subsurface shell thermocouples, points 1 and 2 are the areas where the data from the thermal imager was evaluated. Fig. 4 shows the evolution of temperature over time. The maximum measured temperature was 140°C at a cutting speed of 26 m/min.



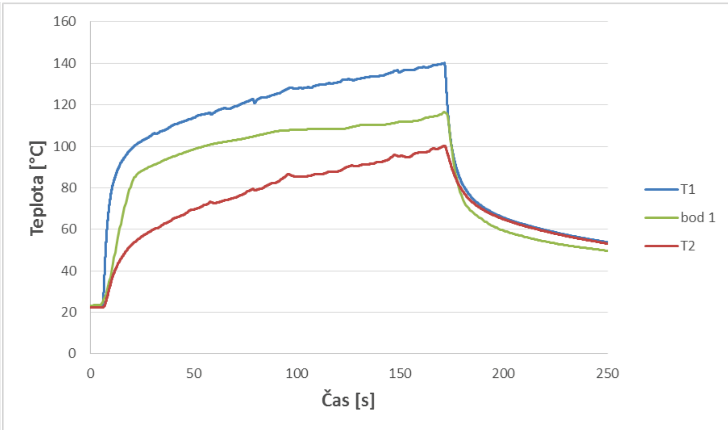




Fig. 3: The thermogram showing points for evaluation, Fig. 4: The comparison of T1 and T2 thermocouples and point 1 data from the thermocamera at cutting speed 26.14 m/min

The data from the T1 and T2 thermocouples was used for input values in a one-dimensional inverse task to calculate the surface temperatures on the head of the turning tool. The outcome values are shown in Fig. 5.

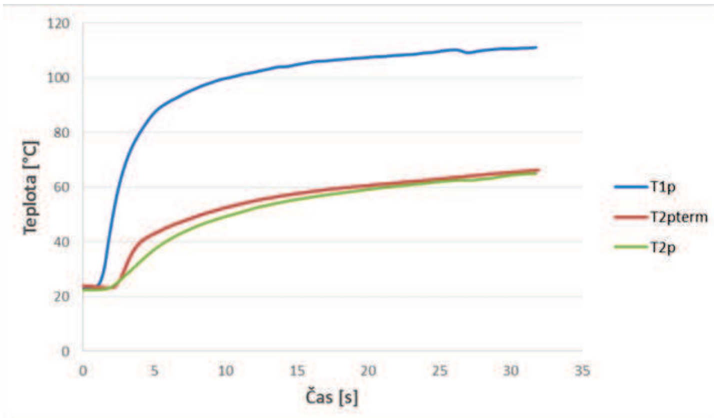



Fig. 5: Comparison of the calculated surface temperatures of T1P and T2P with the surface temperature measured by the thermocamera at a cutting speed 26.14 m/min

## Conclusion

A 10 m/min cutting speed increase can increase the temperature in tens of degrees Celsius. The advantage of using this method is that it can obtain temperatures for places where a surface thermocouple or thermal imager cannot be used, as well as under standard machining conditions (using coolant).

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