Investigation of Temperature Distribution in the Workpiece During High Speed Deep Surface Grinding using FEM

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ABSTRACT

High amount of energy generated in the grinding zone is dissipated as a heat which leads to thermal damage to the workpiece. Heat transfer phenomena in high speed deep surface grinding (HSDSG) is entirely different than conventional shallow cut grinding. Due to high wheel speed and large depth of cut, the temperature rise in the grinding zone becomes very high during high speed deep surface grinding. Therefore, investigation of the temperature distribution becomes important in such situations. In this paper, a two dimensional thermal based finite element model has been developed to investigate the transient temperature distribution within the contact zone as well as in the whole workpiece due to high speed deep surface grinding. After comparing the results of present model with the available results, the model is used to study the effect of different input parameters such as depth of cut, workpiece speed, heat flux profile and wheel material on transient temperature distribution.

Keywords: Contact Length, Finite Element Method, Heat Flux Profile, High Speed Deep Surface Grinding, Temperature Distribution

INTRODUCTION

Grinding is a bonded abrasive machining process where material is removed in the form of tiny chips by means of a high speed rotating disc shaped wheel in which large number of hard abrasives particles having irregular and random geometry are held together with the help of bonding agent. Grinding is mainly used for high quality surface finish and tight tolerances.

Grinding can be classified in terms of applied depth of cut as: shallow cut grinding and deep cut grinding. In shallow cut grinding, depth of cut is kept from 0.001 to 0.05 mm and workpiece speed is kept from 1 to 30 m/min. Shallow cut grinding can be further classified as: low speed shallow cut grinding (30 m/s) and high speed shallow cut grinding (180 m/s). In deep cut grinding, depth of cut is kept from...
Deep cut grinding can be further classified as: high speed deep grinding (wheel speed up to 200 m/s) and creep-feed grinding (workpiece speed ranges from 0.05 to 0.5 m/min). In high speed deep grinding, workpiece speed can go up to 10 m/min whereas in creep-feed deep grinding, speed of the grinding wheel is kept relatively low from 20 to 60 m/s (Tawakoli, 1993).

From the configuration point of view, the grinding process can be used in surface grinding mode, cut off grinding mode and face grinding mode. Therefore, high speed deep grinding (HSDG) can also be further classified as: high speed deep surface grinding (HSDSG), high speed deep cut off grinding (HSDCG) and high speed deep face grinding (HSDFG). In the present work, high speed deep surface grinding (HSDSG) has been considered for the investigation.

Figure 1 shows the basic scheme of HSDSG in down grinding mode. The main characteristics of the high speed deep surface grinding (HSDSG) is the large depth of cut, high workpiece speed, high wheel speed and long arc of contact. It can achieve very high material removal rate and good surface integrity of the ground component. Specific grinding energy in HSDSG can be very low due to high material removal rate (Stephenson et al., 2002).

Rowe (2001b) did the temperature case study of shallow cut, creep feed and high efficiency deep grinding using the sliding and inclined heat sources. Author has shown that sliding heat source model overestimates the
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