Cutting Tool Wear

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ABSTRACT

The article considers a method for measuring tool wear parameters using continuous measurement of cutting temperature during machining.

Keywords: detail, high precision, CNC machine, thermocouple, wear, cutting tool.

The production of high precision parts with the lowest possible time consumption is a major challenge for any manufacturer. To a large extent, the problem is solved by the use of ultra-precision equipment, but often users are not aware of all the possibilities, or deliberately underestimate productivity in an attempt to reduce the risk of emergencies or to achieve their predictable development. This is especially true for metalworking on CNC machines. In the production of expensive and very demanding parts, most often seriously underestimate the productivity of machines, to create a favorable environment for predicting the result at the output. It is not possible to learn about possible defects of the product that has been processed interactively, because measurements and comparison of their values with the standard are possible only after the processing cycle. As a result, we can get both a part that fully meets the requirements and a part that may not even have a chance to be reworked to pass quality control.

Thermal changes in the condition of the cutting surface of the tool can be used as a diagnostic parameter about the condition of the tool [1]. The method of indirect measurement of tool wear parameters by continuous measurement of cutting temperature during machining is based on the relationship between cutting temperature and tool wear parameters for given workpiece and tool materials and sharing given machining conditions and modes. There are many methods of temperature measurement: 1) cutting temperature measurement by the method of two cutters; 2) temperature measurement by thermocouple method, cutter-workpiece; 3) method of infrared thermometry; 4) method of thermoelectric effect.

The measurement of cutting temperatures by the two-cutter method is as follows. Two geometrically identical cutters are machined under the same conditions, but the material of these cutters must be different. Precisely because of the different thermoelectric properties of the different materials of which the tool is made, when a galvanometer is connected between the two cutters, we obtain a thermoelectromotive force proportional to the cutting temperature. However, this method can be used only by having two simultaneously machining tools with identical parameters and modes, which is very difficult to realize if both tools are not located on the same machine.

The cutter-workpiece thermocouple gives the most complete picture of what is happening, as it is possible to obtain the most accurate temperature value and its deviations in the machining zone. However, difficulties with the location of the thermocouple sensors result in large degradations in the value readings.

With infrared thermometry, non-contact temperature measurements are possible. Also using this method of measurement, we get the possibility of non-contact measurement, because usually measurements are carried out with air pyrometers.

Figure 1. shows a schematic diagram of an air pyrometer, where: D - distance to the surface of the object; S - diameter of the spot of temperature measurement;

Based on the properties of the apparatuses, with the help of which it is possible to make measurements, the values of the distance to the measured surface and the diameter of the measured surface will vary. Based on these properties of the measuring apparatuses, we obtain a rigid binding to a location suitable for measurements. Because of the binding to the location it is necessary to solve the question about the protection of the measuring instrument against the actions of the surrounding working environment. The occurrence of chips and build-ups also has a negative effect, as they can complicate and change the measuring conditions.

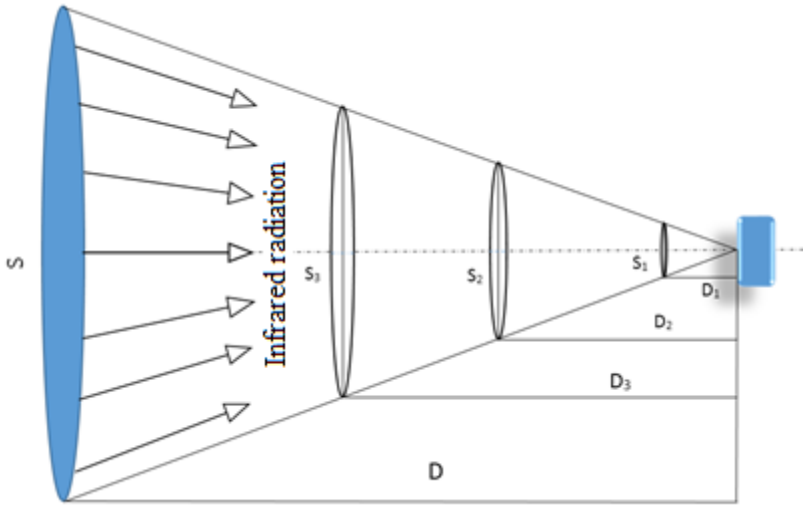

Figure 1.Schematic diagram of air pyrometer operation.

The thermoelectric method measures the electrical conductivity of the tool-to-piece contact. The method is based on electrical phenomena in the contact "tool-detail" when alternating current is passed. The dependence of measured values on chamfer width and cutting tool wear has been experimentally proved. Difficulties arise as to how to isolate the measured elements from all other machine elements. For complete galvanic isolation of the tool from the workpiece it is necessary to carry out complex work on the machine tool, which in some cases is simply impossible, because it may lead to problems in the operation of the machine tool or complete removal of expensive equipment from service, but if you do not carry out complete galvanic isolation, partial or complete failure of the processing machine is possible.

Literature

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