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HEAT TRANSFER IN CUTTING TOOL DURING MACHNING LIKE MILLING. THEORY AND EQUIVALENT THERMAL CIRCUIT

Farida Benabid[1(*)], Hocine Benmoussa[2], Mohamed Arrouf[1], Mekki Assas[1]

[1]Department of Electrical Engineering (ELT), University of Batna, Algeria
[2]Department of Mechanical Engineering (MEC), University of Batna, Algeria
[(*)]*Email:* fari_b2003@yahoo.fr

ABSTRACT

Many problems in machining are related to the adequate cooling of cutting tool and machines. This, in turn, requires the knowledge of the mechanism by which heat is transferred from the tool to the surrounding. Air temperature surrounding the tool when milling (ventilated) is an important factor in the cooling of the tool since it is cooled only by the air. The accurate prediction of magnitude and location of the maximum 'hot spot'of cutting tool is of great importance for evaluating machine thermal performance. The temperature-rise of a cutting tool is the difference between the temperature of its warmest accessible part and the ambient temperature and may be measured by simply taking the difference of two thermometers readings. But owing to the practical difficulty of placing the thermometer close during milling, this method is seldom used. We purpose, in this paper to take measurements of temperatures of mill (point) when the tool is at stand still, then we correct the temperature drop value with reasonable accuracy by resolving the heat transient equation. This will give us a clue for the methods of controlling the cutting temperature and for identifying the causes of development of heat and temperature during milling.

Keywords: cutting temperature, milling, transient heat equation, cooling by air, temperature drop, thermal resistance

INTRODUCTION

The magnitude of the cutting temperature need to be known or evaluated to facilitate the assessment of machinability which is judged mainly by cutting forces and temperatures and tool life, design and selection of cutting tools, evaluated the role of variation of the different machining parameters on cutting temperature, and analysis of temperature distribution in the chip, tool and job[2].

Estimation of cutting temperature in a mill, due to the complex phenomenon during milling and what occurs in contact between cutting mill, chip and work part, which depending on contact resistance, pression, heat sources[1], [3]; so some assumptions were imposed to estimate the temperature cutting. The thermal-electrical analogy is defined in this paper, and then the heat transient equation was applied, where the constant h is a function of rotational speed of mill.

RESULTS AND CONCLUSIONS

In this measurement method, the values taken at standstill were quite 200°C. At first, this conclusion is rather difficult to accept because we are inclined to believe that when the tool leave the chip, the system should simply stop but this is no so as our reasoning shows. The rotational speed remains for 1 second then begin to decrease according to a law. So these values measured were very less than the rating temperatures given by theory. (680°C), as a function of specific energy, and (701°C) by resolving heat transient equation, so these two values are at the same magnitude. The temperature fall is due to the air turbulence created by the rotation of the mill, in contrast, the heat loss in tool in operation like turning, is less than loss in air stream so a linear extrapolation is sufficient to deduct the cutting temperature. It is very practical to include numerical methods in a thermal circuit.

Table 1 - Temperatures results.

t	T°C
12	200
13	199
14	199
15	198.4
16	198
17	198

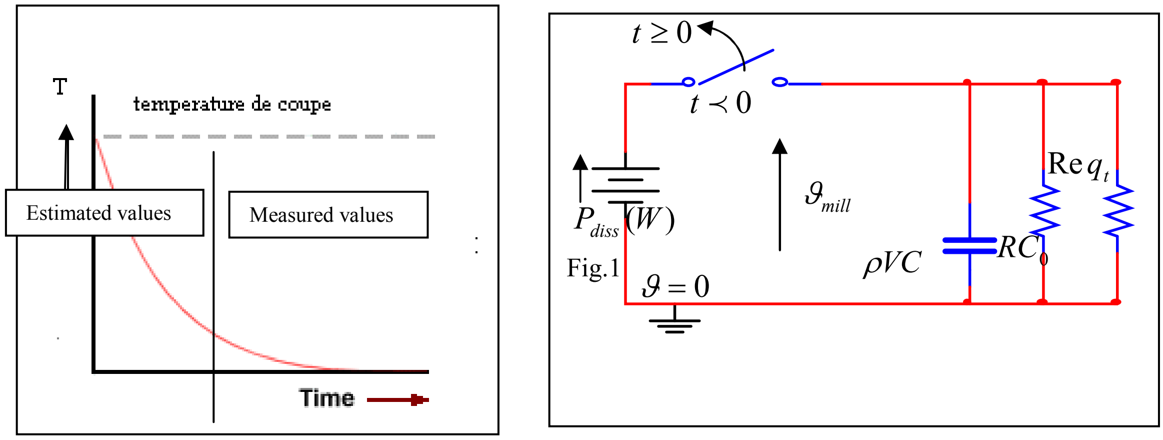

Fig. 1 - Mill cooling and transient thermal circuit.

The afford said method vary with accuracy, preciseness, and reliability as well as complexity, difficulty and expensiveness.

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