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***Technical paper***

# Assessment of Cutting Profile of AISI 1095 by Using Infrared Radiation Approach

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**Abstract**

This research paper determines the relationship between cutting edge temperature, depth of cut, cutting speed, cutting forces and flank wear. The cutting edge temperature is determined by using a pyrometer consists of Indium Arsenide (InAs) and Indium Antimonide (InSb) photocells to detect infrared radiation that are released from cutting tool's edge and cutting forces is measured by using a dynamometer. The machining process experiment is done by end milling the outer surface of AISI 1095 carbon steel. The output signal from the photocell and dynamometer is processed and recorded in the digital oscilloscope. Based on the results, the cutting edge temperature and cutting force increases as the depth of cut increases. Meanwhile, increasing cutting speed resulting in cutting edge temperature increases but decreasing in cutting force due to thermal deformation. Also, existence of progressive flank wear at cutting tool causes an increment in cutting edge temperature and cutting force proportionally.

***Keywords***: *Cutting edge temperature; Cutting force; Flank wear; Milling; Thermal deformation.*

## 1. Introduction

Material removal operation is important in the machining industry. It can give desired shape to the product based on the user's needs. Temperature measurement of cutting tool during machining process is an important approach to assess the tool wear, cutting performances, cutting operation, and surface integrity of a final product. Currently, most industries and researcher used thermocouple technique and thermographic technique in milling, turning, drilling and grinding to assess the cutting temperature in the machining operation [1].

It is important to identify the cutting temperature of cutting tool. Cutting temperature of Inconel 718, TI6–4 and carbon epoxy fibre composites are studied by [2]. They found that machinability of these materials is closely related to cutting temperature. Cutting temperature variations between up milling and down milling were also investigated by [3]. They found that the temperature for up cutting is increasing gradually during cutting period and stagnant at peak value just after cutting followed by decreases steadily during noncutting period. A different trend is observed in down milling where the cutting temperature reaches maximum temperature instantly after cutting starts then decreases over sequence period. They postulated that the rate of temperature increase in down milling is higher than up milling.

Several researchers have done a study on a rare workpiece such as carbon fibre-reinforced plastics (CFRP) with a cemented carbide end mill tool instead of abrasive water jet (AWJ) as cutting tool. [4] relates transitions of cutting temperature with the surface integrity of machined CFRP and thermal electromotive force at a cutting speed range of 25 m/min to 300 m/min. They observed that the matrix of machined CFRP's surface is not affected even if the cutting speed is as high as 300 m/min and therefore it is suitable to use cemented carbide end mill tool to machine CFRP.

Another study on end milling using carbide tool with a difficult-to-machine material, TiAl6V4 is performed by [5]. They compare between mathematical models and thermocouple technique at low cutting speed. The output of their research is increasing cutting speed and feed per tooth will increase temperatures at tool-chip interface.

Experimental study of laser-sintered material's machinability by ball end milling is carried out by [6]. Ball end milling tends to have a major fracture when cutting a laser-sintered material. They studied on the effects of machining a laser-sintered material when surrounded by unsintered powder and the condition of cutting tool. The outcomes of their research is life of cutting tool when cutting a molten sintered powder's workpiece is better than a laser-sintered material surrounded by unsintered powder. They found that cutting temperature of cutting molten sintered powder's workpiece is much lower than the latter.

Recently, an experiment to investigate relations between tool wear of TiCN (Titanium Carbo-Nitride) coated cemented carbide with inclination angle of milling process, oblique angle of cutting edge, cutting force, surface roughness and cutting temperature was carried out by [7]. A workpiece is made of 13 Cr Steel and the cutting temperature is measured using thermocouple method. The result of their investigation shows minimum wear of TiCN coated cemented carbide takes place at cutting velocity of 400 m/min when cutting speed is changed from 100 m/min to 800 m/min. They

conclude that the optimal cutting speed exists between low wear mechanism of tool and at high velocity conditions.

Based on these literature reviews, an optimum cutting conditions are possible to be found if tool wear, cutting edge temperature,