

Determination of Tool Temperature in Orthogonal Metal Cutting by Finite Element Method and its Comparison with Experimental Work

A.Fata; M.R.Razfar

ABSTRACT

Machining of steel inherently generates high cutting temperature, which not only reduces tool life but also impairs the product quality. Further, the lubricant effect deteriorate the working environment and lead to general environmental pollution. In this work, the cutting tool used is uncoated carbide insert with st37 steel as workpiece material to measure the temperature of the tool-chip interface in dry turning. Two different approaches are implemented for temperature measuring: an embedded thermocouple into the cutting tool and infrared camera. Comparisons are made between experimental and FE results. The influence of cutting speed, feed rate and depth of cut on the temperature are investigated. Afterwards, an expression for the effects of cutting conditions on tool temperature are determined using a design of experiment developed by factorial regression method. With the aid of experimental results is concluded that the main factors of the increasing cutting temperature are, cutting speed, feed rate and depth of cut respectively, It is also determined that interaction between cutting speed and feed rate has maximum effect on increasing in cutting temperature.

KEYWORDS : Cutting temperature; thermocouple method; Temperature distribution; Orthogonal cutting; Finite element.

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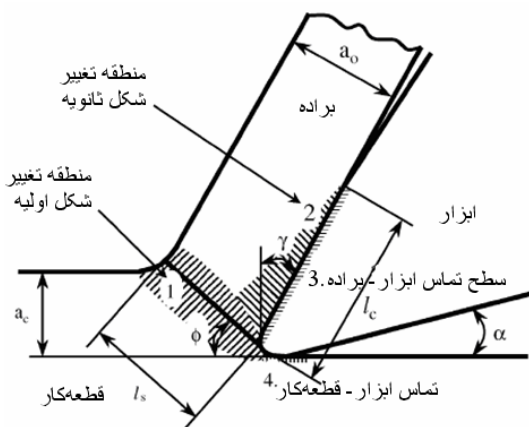
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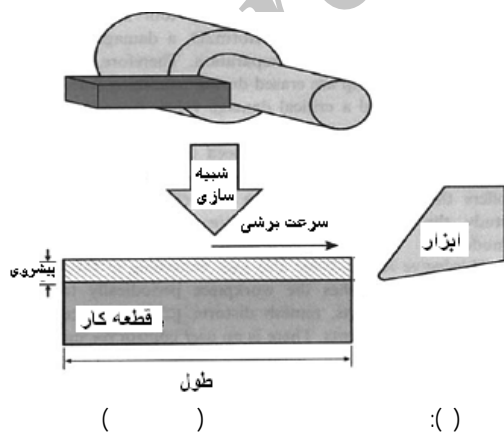
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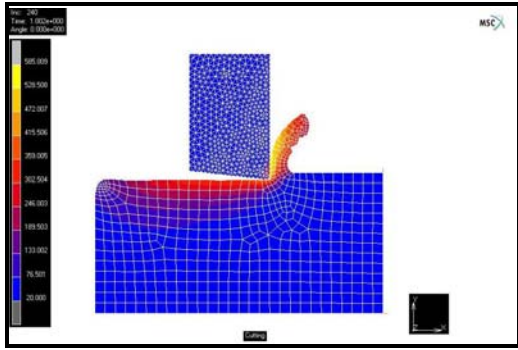


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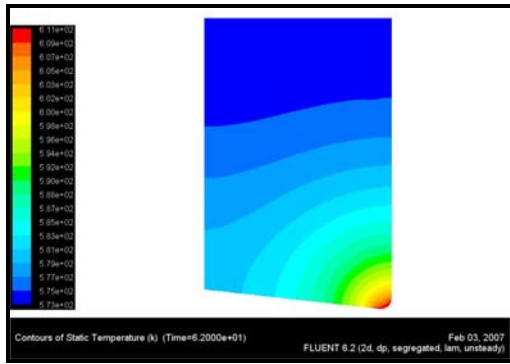


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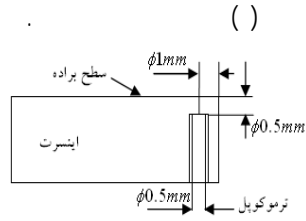
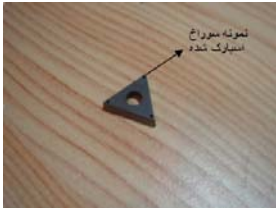
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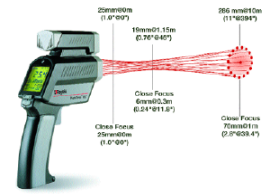
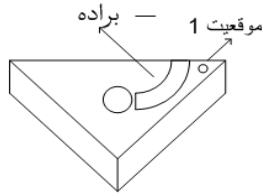
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$$q_e = \epsilon \sigma T^4$$

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$$5.675 \times 10^{-8} \text{ (W/m}^2\text{K}^4)$$

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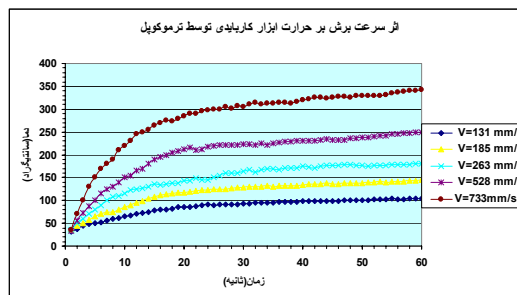
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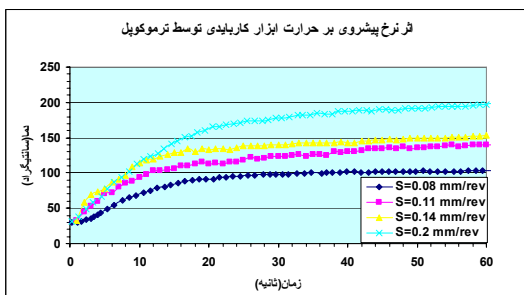
ST37	$\frac{mm}{s}$	$\frac{mm}{rev}$	()
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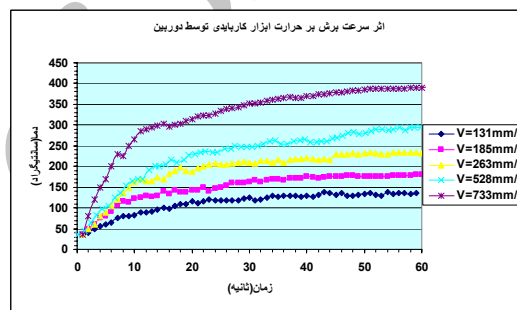
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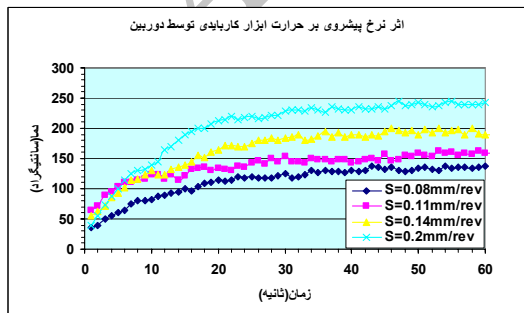
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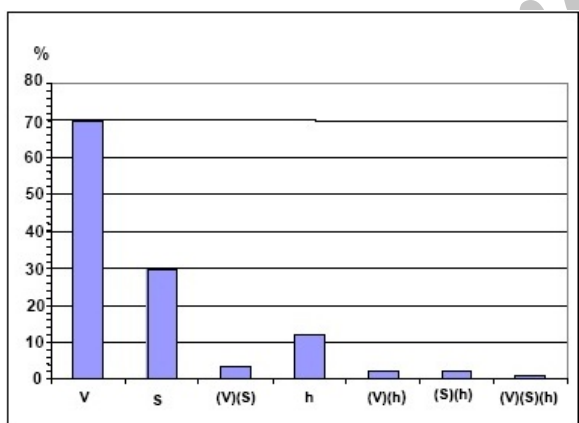
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ST37	
mm/s	mm/s
mm/rsv	mm/rsv
mm	mm

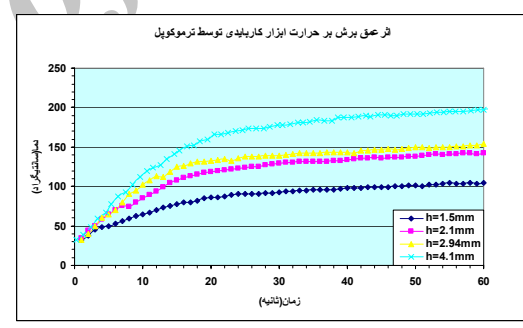
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mm/rsv	mm/rsv
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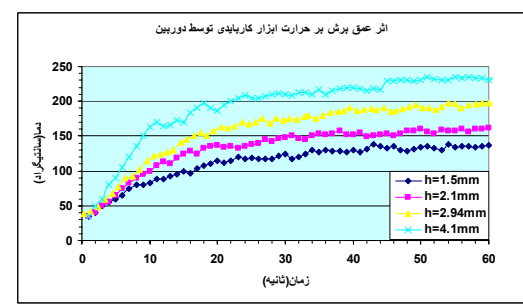
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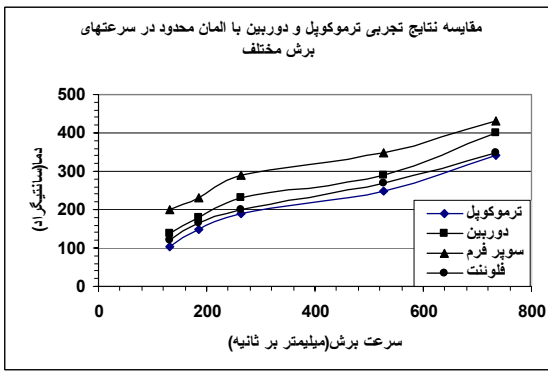


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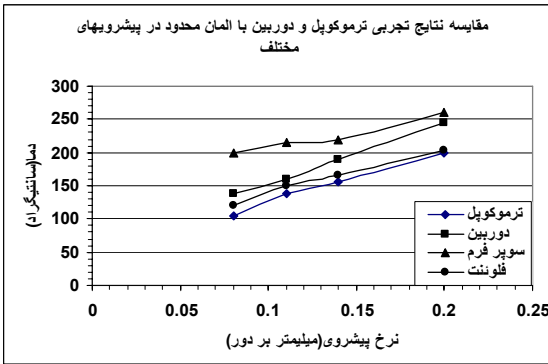
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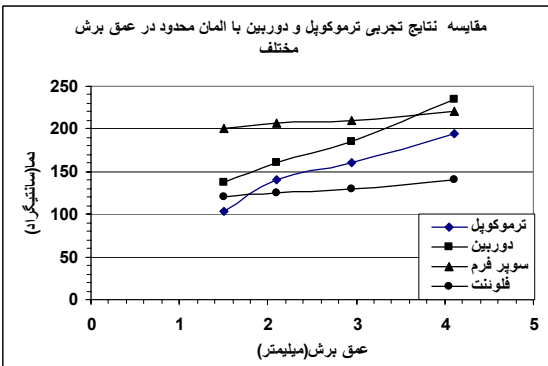
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$$T = \bar{T} + \left(\frac{\Delta V}{2}\right)V + \left(\frac{\Delta S}{2}\right)S + \left(\frac{\Delta h}{2}\right)h + \left(\frac{\Delta VS}{2}\right)VS \quad ()$$

$$VSh \quad Sh Vh$$

\bar{T}

T

$\frac{\Delta}{2}$

$$T = \bar{T} + \left(\frac{\Delta V}{2}\right)V + \left(\frac{\Delta S}{2}\right)S + \left(\frac{\Delta h}{2}\right)h + \left(\frac{\Delta VS}{2}\right)VS \quad ()$$

$S \quad V$

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1.5mm 35m/min

45m/min

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Dogu, Y.; Aslan, E.; Camuscu, N. ; "A numerical model to determine temperature distribution in orthogonal metal cutting"Journal of Material processing & Technology, p.p. 171-180, 2005.

Fleischer, J. and Weule, H.; "Estimation of Two-dimension Tool Wear Based On Finite Element Method". University of karlsruhe(TH)

Sullivan , D.O. and , Cotterell, M.; "Temperature measurement in single point turning", Journal of Material processing & Technology, p.p. 301-308, 2001.

Barrentine, L. ; Design of experiment., Oxford University Press, 1999.

Shaw, M. C.: Metal cutting principles, Oxford University Press, 1984.

Filicie, L. and Umbrello, D.; "On the finite element codes capability for tool temperature calculation in machining processes", Journal of material processing Technology, p.p. 182-190, 2006.

Silva, M. and Wallbank, J.; "Cutting temperature: prediction and measurement methods a review", J. of material processing, p.p. 195-202, 1999.

Komanduri, R. and Hou, Z.B.; "A review of the experimental techniques for the measurement of heat and temperature generated in some manufacturing processes and tribology", Tribology International, vol. 34, p.p. 653-682, 2001.

Korkut, I.; Boy, M. ; KARACAN, I.; Seker, U. , "Investigation of chip-back temperature during machining depending on cutting parameters",



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Taylor
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Moraka
Shay
Msc-Superform
Adaptive Remeshing
Fluent
Heat Sink
Matlab
Yokogawa
Testo
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Full Factorial

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